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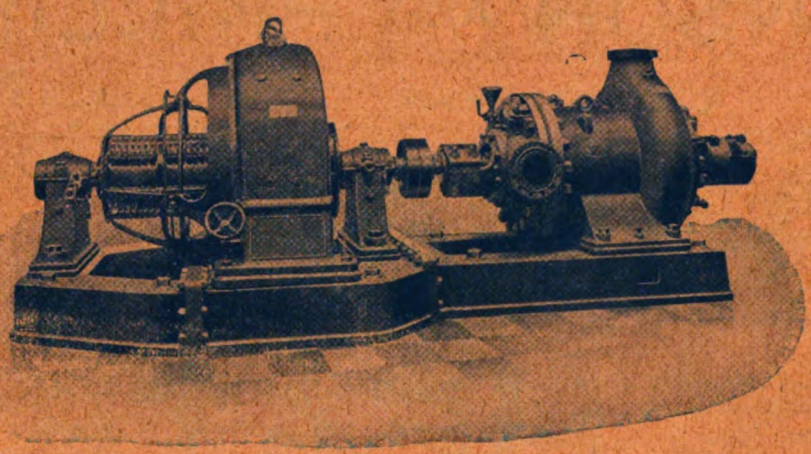

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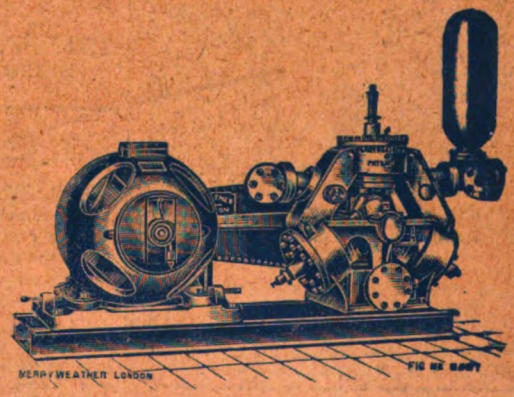

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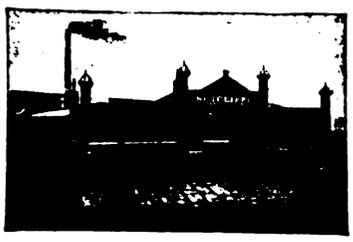

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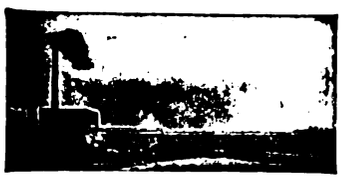

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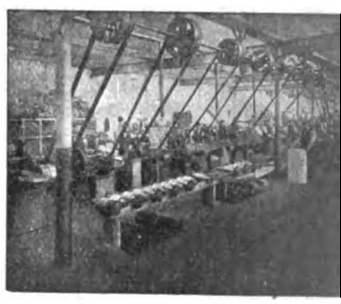

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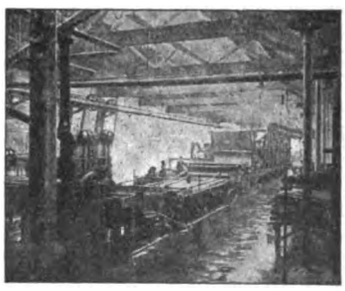

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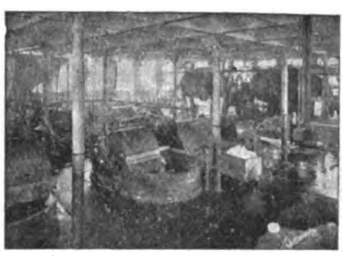

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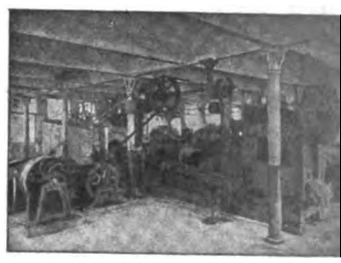

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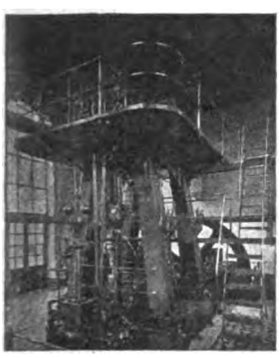

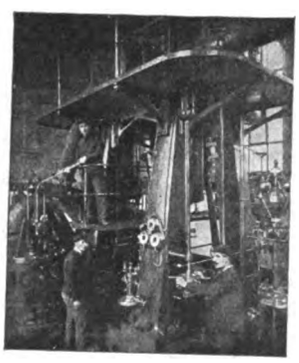

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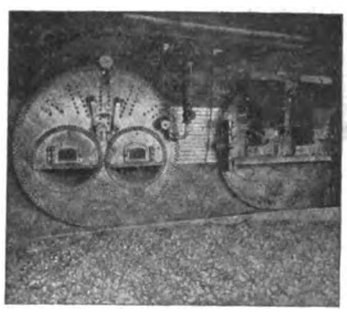

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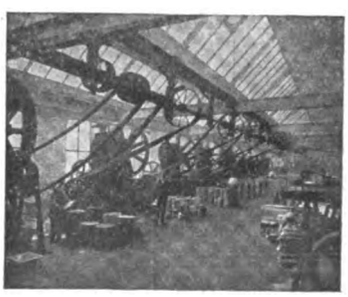

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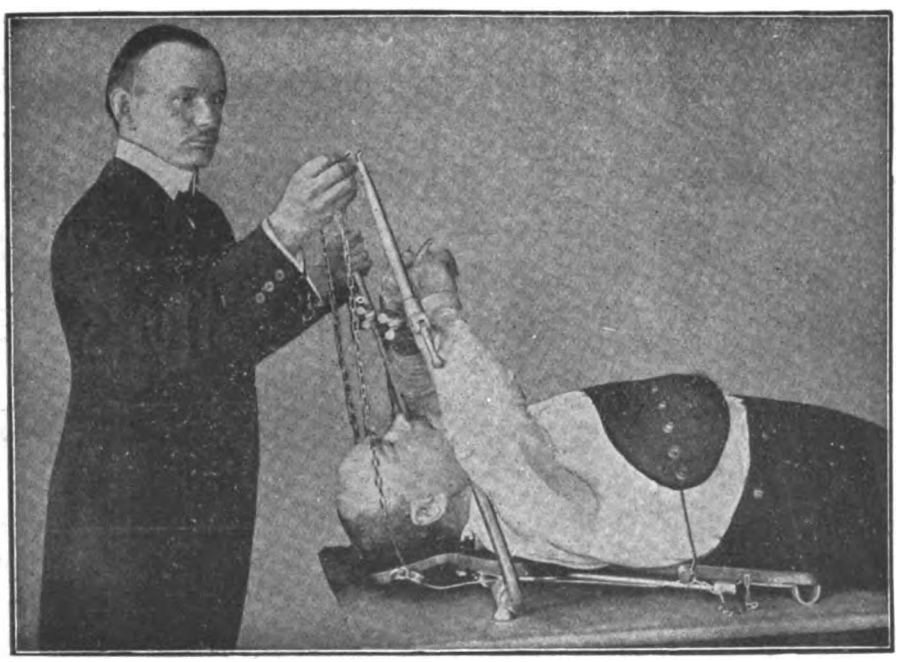

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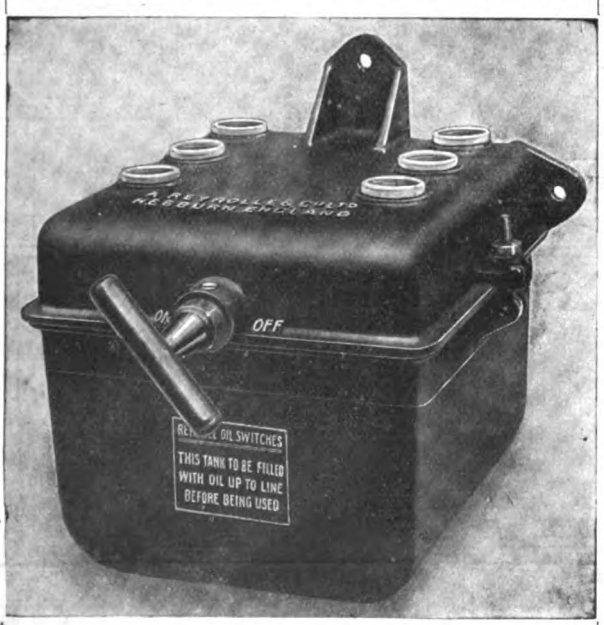

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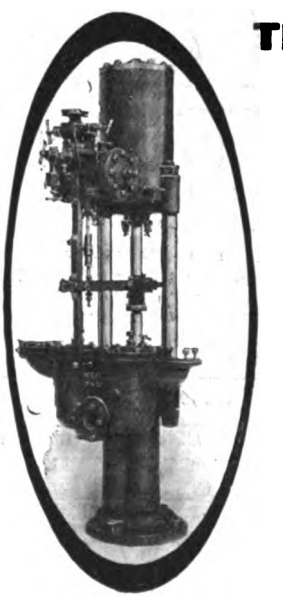

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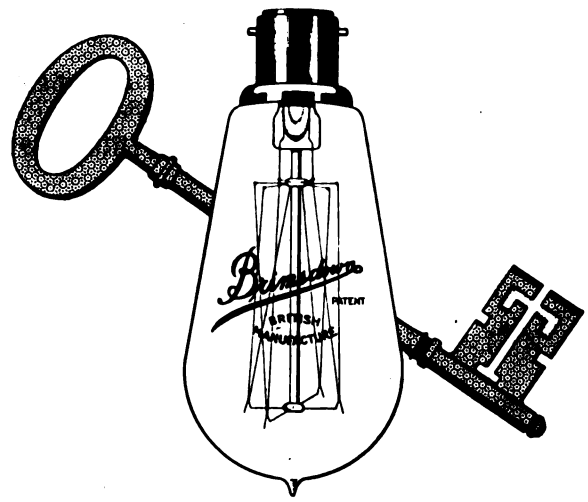

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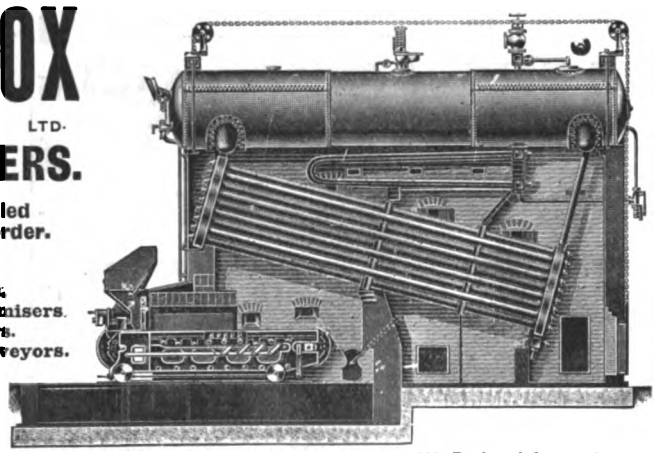

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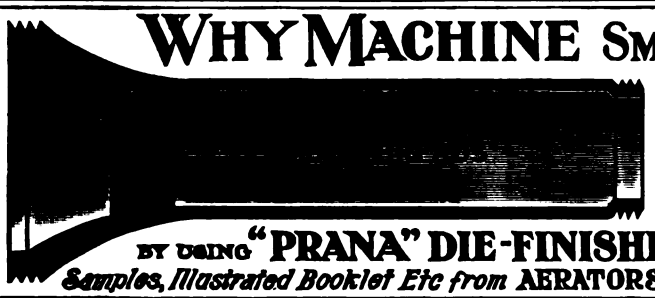

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NOTES.

IN this, the first number of the ELECTRICAL ENGINEER for 1912, we take the opportunity of wishing our many friends in the electrical world a happy and prosperous New Year. By all accounts it is being entered upon with very hopeful feelings. Many new electrical enterprises are either already arranged or definitely foreshadowed, especially in relation to traction, in which respect many developments are promised in connection alike with railways and tramways and the trackless trolley system. The industry has passed through a period of depression, but it seems to be agreed on all hands that livelier prospects are opening up in all directions. The united activities of the British Electrical and Allied Manufacturers' Association, and the Electric Supply Publicity Committee, together with the individual efforts of large manufacturing firms are to bring about an advertising campaign on bolder lines than any yet attempted, and this should have a very stimulating effect in regard to the popularisation of electricity for domestic purposes. In this connection we may call attention to a short series of articles on the Evolution of Electrical Publicity, the first of which appears in to-day's issue. By giving some representative examples of what has already been done in regard to effective publicity, we are endeavouring to point the way to still larger possibilities in this direction and to indicate later some of the lines on which publicity campaigns may be carried on among consumers in order to ensure the best results. The gas industry is entering almost immediately upon a series of such schemes under the guidance of its newly-formed organisation, and it is for the electrical industry, which first set at work the activities of the rival concerns, to "go one better." When the enemy is on the move it behoves the electrical army to be on the move also.

NO one in these days, least of all the gas concerns themselves, doubts that electricity is destined in time to supersede gas both in the home and in the factory. It is the business of the gas companies to delay that halcyon period by every means in their power, and judging from what has happened in the past, they are not likely to be over-scrupulous in the methods they will employ to encompass this end. The fight is going to be a heavy one, and the greater the success of electricity, the keener will be the conflict. The gas industry is represented already by a capital of between £135,000,000 and £140,000,000 sterling, and according to our contemporary "The Gas World"—to whose honest and fair-minded method of dealing with electrical matters we should like to pay passing tribute—application will be made in the coming session for sanction to additional enterprises involving a further sum of close upon £1,750,000; an increase of half a million sterling upon the total value of undertakings similarly applied for during the past year. It is also worthy of note in this connection that stronger insistence than ever is being laid upon the principle of amalgamation, and it is from this source of united effort that the electrical industry has most to apprehend. Since the beginning of 1910, the Gas, Light & Coke Company, already the largest gas enterprise in the world, absorbed three competitive or partially competitive companies with a total capital of nearly a million and three-quarters, and its aggregate share and loan capital is now £29,000,000. This year the Wandsworth & Putney Company, the Mitcham & Wimbledon Company, and the Epsom

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Company are seeking to amalgamate their capital of £1,362,000, and the South Suburban, the Bromley, and the West Kent Companies are also seeking amalgamation, with a capital of £1,360,000. This consolidation of various interests means a material increase in the fighting strength of the combined forces, and according to information which reaches us from a correspondent, a sum nearer £100,000 than the £15,000 or £20,000 which has been mentioned is to be expended this year upon gas advertising, leaflets, and booklets. Whether this be so or not, the journals devoted to the gas industry leave us under no misapprehension as to the fact that that industry means fighting, and fighting hard.

THE SCIENTIST, and especially the electrical scientist, is once more conspicuously absent from the Honours List. Among the new peers there figures the head of a wholesale drapery firm, and the new baronets include a coalowner, two shipowners and a financier, whilst knighthoods have been conferred, among others, upon a philanthropic pill maker and a milk contractor in a large way of business. Indirectly some lustre is thrown upon one branch of science by the baronetcy conferred on Mr. Collingwood Forster, who has done good service in promoting the study of chemistry, but for the rest only grudging recognition is accorded. Such as it is, we must, however, be grateful for it. Everyone will rejoice that Professor William Fletcher Barrett, Professor Tyndall's old assistant, who has devoted his life to scientific research, has been given a knighthood. Professor of Physics at the Royal College of Science, Dublin, for close on forty years, Sir William Barrett will be best remembered so far as the electrical side of his work is concerned by his researches into the electric and magnetic properties of alloys of iron. A knighthood has also been conferred on Dr. James Mackenzie Davidson, who has done such valuable work in connection with Röntgen rays and is surgeon in charge of the X-ray department of the Royal London Ophthalmic Hospital and elsewhere. Similar recognition is made in the case of Dr. Alfred Bray Kempe, the treasurer of the Royal Society, and Professor Henry Alexander Miers, of London University; but there the list ends. The rich nobody gets his reward for political services rendered to the treasure chest, but the men who have enlarged the boundary of mortal vision and given the best years of their lives to increasing the sum of human knowledge are left to find that science, like virtue, must be its own reward.

IN case it should escape the attention of the gas publicity organization, it may be mentioned that no instance of a fatal gas explosion has been recorded in the United Kingdom during the past week. Mr. Robert Hopkins, Mrs. Hopkins, and their son, who were hurled to the ground and shockingly burned about the head, face and hands by an explosion of gas at their house in Kingsland are, we understand, progressing as favourably as could be expected in the circumstances. But the windows of their house, we read, were "blown bodily into the road, the venetian blinds torn to shreds, the furniture shattered and hurled in all directions, whilst the ceiling collapsed." Such a nice, safe thing, gas.

ANNOUNCEMENT is made of the discovery in a platinum mine in the Nelson district of British Columbia of a new element to which, in honour of the locality, the name Canadium has been given. This metal is stated to be wholly new to science, and is likely to prove of exceptionally high commercial value. Ranking somewhere between ruthinium and molybdenum in the platinum group, Canadium is beautifully white and brilliant and occurs pure in semi-crystalline grains, in short rods, and also as scales in platinum ores. It does not tarnish on exposure, nor is it oxidised on heating with a blow-pipe. It is soluble in nitric and hydrochloric acids, and in aqua regia, and its melting point is lower than that of fine gold and silver, and much lower than that of palladium. From the mine in which it was found platinum, iridium, palladium rhodium, and osmium have been obtained. It occurs in the ore in quantities varying from a few pennyweights to three ounces per ton. The discoverer is Mr. Andrew Gordon French, formerly of Glasgow.

FOUR serious cases of accidents in connection with electric tramways, involving two deaths, and all occurring within a couple of months, seem to indicate the need for a much closer investigation than has yet been made into the brake equipment of these cars. In the Forest-hill case which came before the Southwark coroner last week it was declared by some of the witnesses that the car got out of control and "ran downhill at the rate of thirty to forty miles an hour." A passenger's evidence on this point, however, is of very little value. In the excitement attendant upon a "runaway," there is an unconscious though perfectly honest tendency to exaggeration, apart from the fact that in any circumstances it needs expert knowledge to judge speeds with any approximation to accuracy. But there seems to be little doubt that in this case the car was running at about fifteen miles an hour, which is a quite sufficiently dangerous pace in a populous neighbourgood, and the result was that a young lady assistant at Harrods Stores was knocked down and killed. The conductor of the car and other witnesses declared they heard a loud report and saw a flash of light, circumstances which the former attributed to "the circuit breaker coming out," a view which was confirmed by the driver. The car was travelling uphill at the time the flash occurred, and if the current breaker came out the effect would be to cut off the current and thus allow the car to run backwards by its own impetus. The car was eventually stopped halfway down the hill by means of the magnetic brake. These are the bare facts as stated before the Coroner, and obviously they leave many gaps for the filling in of which we must await the report of the Board of Trade.

MEANWHILE there are some important considerations involved in Lieut.-Col. Druitt's report on the Accrington case in which, it will be remembered, twenty passengers were injured in a collision between two cars belonging to the Rawtenstall Corporation, one of which was fitted with the Raworth Regenerative Control System. The driver of this car stated that when he was on a falling gradient of about one in twenty he fed up the controller handle normally until he reached the thirteenth notch, when the motors would be in full parallel and the car should have gone at about ten miles an hour. But just as he had cleared the loop points the car shot away at a high speed, and although he dropped sand all the time, and after first trying the electrical brake, and lastly the wheel brakes and slipper brakes, he was unable to regain control of the car, which after running 356 yards on a falling gradient varying from one in seventeen to one in twenty-nine, reached the facing points of the next loop and owing to its high speed jumped them, with the result that the right hand corner of the car collided with the right hand corner of the other car which was waiting in the loop. The cause of failure in this case was very clearly stated by Mr. Stewart, the electrical engineer and tramways manager of the Rawtenstall Corporation. It lay in the fusing of the shunt coil of the No. 1 motor, the motor which would take the current from the trolley wire first. The result of this fusing of the shunt coil was stated by Mr. Stewart to be that the car instead of being driven steadily at a speed of about ten miles an hour was driven forward by a powerful current, and as the gradient was a rather steep falling one, the car gained at once a very high speed. Evidence was given that an examination on the previous day disclosed no evidence of any defect or of anything likely to lead to a fusing of the shunt coil, and this leads Lieut.-Col. Druitt to the conclusion that "even with the most careful examination of a car fitted with this system of control before being put into service, a similar failure might occur, and so to prevent a repetition of a runaway, either cars so fitted should not

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be run on any but level routes, or else some further precautions must be taken to prevent the fusing or breaking of the shunt coils."

TO this rather serious expression of opinion Lieut.-Col. Druitt adds that he does not consider cars fitted with regenerative control are so suitable as ordinary cars for steep gradients, as it is not possible to coast down a gradient with the former by means of the application of the slipper brake and wheel brakes, as the current cannot be cut off by the controller handle being brought into the off position, until all the electric braking effect has been brought into play, and the car thereby brought almost to a standstill. Those who have followed the articles on regenerative control which have appeared during the past year in the ELECTRICAL ENGINEER will not, we fancy, find themselves altogether in agreement with Lieut.-Col. Druitt, but at any rate his observations seem to call for some fuller investigation into the question, In a note appended to Lieut.-Col. Druitt's report by Mr. A. P. Trotter, the Electrical Adviser to the Board of Trade, it is observed that "the termination of a shunt winding in a fine wire is a defect of construction. Both at the inner and at the outer end of the fine wire a stout wire strong enough to stand handling and cleaning should be carefully jointed. This stout wire should be wound three or four times round the magnet before bringing out. It is not likely," Mr. Trotter adds, "that the shunt wire was fused, unless part of the shunt winding was short-circuited or unless very high voltage had been produced by regeneration. The wire is likely to corrode where it leaves the magnet, and may have sparked on breaking and may thus have shown signs of fusion." Here we get at once a basis for inquiring the question whether, in fact, such high voltage was produced by regeneration as to fuse the shunt wire. On this point it would be very interesting to hear the views of Mr. Raworth himself. In any event, the matter can hardly be allowed to stop at the point where Lieut.-Col. Druitt leaves it.

WHILE on the subject of tramway matters it is interesting to note that three young Welshmen are responsible for an invention for automatically operating tramway points, of which more is likely to be heard. As described, the invention can be used on any system, as the driver simply operates the points from where he stands, and the device is designed with this object. A car fitted with the invention has an auxiliary wheel rim, worked by an axle, and adjusted by means of a rack and pinion from the driver's cab. When the driver comes to a "point" a wheel is turned in order to operate the rack, so that a rod and slotted block can engage the upper end of a lever. Adjacent to the "point tongue" and forming one side of the rail groove, is a pivotted bar, which, when depressed by the auxiliary wheel rim, gives a triple screw one quarter of a turn, and so moves the "point tongue" over. Immediately the car has passed a spring returns the points to their normal position.

ACCORDING to an announcement in the "Times," Herr Kiebitz, of the German Post Office, has successfully established telephonic communication between Berlin and Canada by means of earth waves, no aerial or antenna being employed. The system was originally foreshadowed by Professor Zehnder, following on the researches of Preece, but it has remained for Herr Kiebitz to carry it out to its logical end and put it in actual practice. The impulses are transmitted by means of a special type of generator, which gives alternating current of a frequency of about 100,000 cycles per second. The transmitting instrument is connected by two wires of a certain fixed length to two plates placed in the earth, the distance separating these plates depending on the apparatus, and being equal in length to half that of the waves transmitted. A similar arrangement is used to pick up the waves, and either telegraphy or telephony can be carried on.

TO Germany also belongs the distinction of having achieved a distinct advance in ordinary telephony, a party-line system having been invented which ensures absolute privacy for each subscriber. The principal feature of this new system is stated to be a switching relay so constructed as to be extremely sensitive to direct electric currents, yet unaffected by alternating currents. When the private subscriber lifts his receiver he automatically calls up the exchange, as of old. At the same time certain electro-magnets are brought into operation which disconnect the common call and switching line. The result is that other subscribers cannot destroy or overhear the existing connection. Should the exchange, on the other hand, initiate the call, they send an alternating current of definite frequency through the whole circuit. Only the bell tuned to this frequency rings, so that only one subscriber amongst the number on the line receives the signal. The moment he removes his receiver he isolates himself from all his neighbours. Conversation between neighbours on the same circuit is the most complex of the operations, yet it is quite simple. The exchange is first called, and the operator changes the direction of the current on the central circuit and calls up the neighbour. Once he is obtained, the exchange again reverses the central circuit. In this country the party-line system has never been popular, for the simple reason that any of the three or five party-line subscribers can "tap" the conversation of any other of the subscribers to the same set; and it was this circumstance which killed Mr. Samuel's farmers' telephone system at its inception. It is understood that the Postmaster-General is negotiating for the English rights of the new German system, and if he is successful there will doubtless be a big future for cheap party-line telephones in this country.

Professor Zehnder, whose name was mentioned earlier in these notes, claims to have invented a cipher for use in connection with wireless telegraphy which it is absolutely impossible to decode without a key and is at the same time susceptible of almost infinite variation. Describing his process in the "Zeitschrift für Schwachstromteknik," he points out that owing to the occurrence of the letters "E," "I," "N" and "S" in a well-proportioned frequency it is always possible in an ordinary cipher message to pick out the letter of the greatest recurring frequency by counting the number of times in which certain letters, figures or symbols recur. Nearly a generation ago, Dr. Zehnder was asked to tackle this problem for the Abyssinian Secret Service and he then invented the system which he has now brought up-to-date for use in connection with wireless messages. The system is very simple. You simply write down as many alphabets as you please, but with all the letters in a different order. Each line of jumbled alphabet is written on a tablet, and above them all is an alphabet in proper sequential order, thus—

a	b	c	d	e	f	g	h	i	j	k	l	m	etc.
f	p	l	q	s	w	t	b	u	h	a	k	z	
c	h	a	r	i	l	n	s	t	u	p	f	v	
b	d	g	o	i	m	p	f	j	k	w	e	y	

If the first line or the first word of the despatch is written with one of the distorted alphabets, the next with another, the following with a third, and so on, until all the distorted alphabets are used up and a fresh start is made with them, no counting of letters will avail the would-be decipherer. The more distorted alphabets used the greater will be the uniformity with which the letters occur and the key becomes the only means of reading the cipher. These ciphers have the advantage of being easily written and deciphered with the aid of a typewriter. The simplest case is when only one distorted alphabet is used, but for each fresh line the alphabet is pushed forward by one letter, and in machines fitted with a type-bar an altered alphabet can be brought into use for each line by the operation of a lever. If on the other hand a fresh alphabet is used for each line the type roller can be moved by means of the space bar.

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The State and the Telephone System.

SOME PRACTICAL CONSIDERATIONS FOR THE GOVERNMENT.

By L. R. Gleason.

On Monday last the entire telephone system of England passed into the hands of the Government and became an integral part of State-controlled business. Exactly what may be the outcome of the transfer it is, at the present, impossible to say; we can only hope for the best. It is not possible for those outside of the engineering staff of the G.P.O. to say what the Government is going to do towards providing the capital city of the world with a really adequate telephone service, but it is greatly to be hoped that the results will be such as to justify the arguments of those who believe in (to coin a phrase) a State-controlled everything.

Now there is a type of person most perfectly described by the late Sir W. S. Gilbert in the "Mikado" as—

> The idiot who praises, in enthusiastic tone,
> All centuries but this one, and all countries but his own.

Having had the misfortune to meet some of that genus, I am heartily of the opinion that "They never would be missed." I preface my comments in this way because I do not wish to be classed with those who habitually "run down" their Country and Government.

No one can deny that we have, perhaps, the best telegraph system in the world. No one can conceal the fact that our telephone system is archaic in conception and inefficient in practice.

It has been said by some that the Post Office have not developed the telephone because they have feared that it might cause a loss in the receipts of the G.P.O. telegraphs. I cannot think that such an idea is justifiable but, as a telephone engineer, I cannot say that the G.P.O. have ever taken the trouble to remove such a thought from the public mind.

It cannot be too clearly understood that the telegraph and telephone meet definite needs of mankind in general and do not in any way overlap. As a means of communication, each is, in its own way, perfect; but there is this great difference—no ordinary person uses the telegraph system unless he has to, that is, it is used as means of transmitting urgent messages for business or private purposes and not for a friendly interchange of conversation. In fact, one can sum it up that the ordinary person uses the telegraph system when he has to and the telephone system when he likes to.

Apart from the business firms who have to employ both systems of communication, it comes to this: for the ordinary suburban dweller the telegraph system is to hand if he needs it, but the telephone in his home is a luxury and one that cannot be obtained any too readily and then only by payment in advance. Therein lies the grave mistake that both the G.P.O. and N.T.C. have made. They have not realised that they had something to sell. Something that to the ordinary family was not exactly a necessity, but a very great convenience; so great a convenience that few people who have been connected with an exchange, no matter how wretched the service, will willingly dispense with the telephone. Now, I am not an apostle of the art of advertising, particularly in the way it is sometimes practised, but I know it to be a fact that if you have something to sell you must, in some way or another, announce that fact to the public and stand or fall according to the merits of your merchandise, and I make this charge against the General Post Office and National Telephone Company: that they have never in any way "gone after" business or attempted to explain to the general public the great usefulness of the telephone; that they have left it to the public to come to them to ask for connection, and have met such requests with un-business-like delays, formidable contracts and unsatisfactory service.

However, it is not much good to advertise that you have something to sell to everyone if you are not prepared to meet the demand which you may create, and for that reason I am going to draw attention to the way in which telephone service is supplied in America by the Bell Telephone Company. It is possible to outline their general policy as follows. They have something to sell. There is a demand for what they have to sell, and it is sound business that they shall increase that demand. They are prepared to meet that demand in whatever direction it may grow, and that they may continue in a position to meet that demand they are planning all their work on a basis of what may be required thirty years hence. They give a most satisfactory service and encourage the public to make use of the telephone in every way possible.

They advertise in every paper and magazine published in the United States—a tasteful, well-illustrated and attractive advertisement suggesting the possibilities of the telephone and pointing out how the public may best use it to their advantage. We English people are not so susceptible to the effects of advertising as are Americans; but it cannot be denied that we are affected by it though usually in a sub-conscious manner, and whilst I sincerely hope that we will never have our rocks and trees defaced with stencils proclaiming the merits of Somebody's Pills, I cannot be blind to the advantage of a well-chosen and worded advertisement in the daily and magazine Press.

Given the fact that you have something to sell and that the public are willing to buy, there arises the great problem of efficient distribution.

With the telephone business, above all others, this point is of paramount importance and is the one thing upon which the telephone engineer must concentrate. Telephony is long past the experimental stage, and such matters as transmission equivalents, induction, etc., can all be met and successfully combated, thanks to modern research, loading coils and formulæ. Work of this nature is left to a special department and the ordinary telephone engineer devotes himself to planning the telephone service so as to give the maximum satisfaction to the hoped-for maximum number of subscribers with the minimum of annual expenditure to the company. Work of this nature is highly specialised and requires a special training. The electrical engineer who has no connection with telephone work can have no more conception of its nature than any ordinary business man. The day may come when telephony, in the true engineering sense, will be taught in our technical schools, and I hope that it may not be far off, for, given sufficient appropriation for the extension of plant, there is plenty of room in England for the telephone engineer.

To describe as briefly as possible the way in which the New York Telephone Company meets the ever-growing demand for telephone service may be of some interest to those readers who are connected with the telephone industry, and to such I would like to say that I firmly believe that we, as a race, can carry out successfully whatever any other nation can attempt.

It is obvious that telephone distribution in such a city as New York presents many difficulties, since the business centre of the city is situated at the lower end of the island of Manhattan, which is about 12 miles in length and about 2 miles in width at its widest point.

The great pile of buildings which (to my mind) deface the sky-line, require an enormous number of telephones; indeed, I believe that in one huge building (The Hudson Terminal) there are more than 3,000 instruments, and similar large buildings continue to be erected with an ever-growing demand for telephone service.

Such a growth is cared for by the installation of large cables of about 600 pair size, and by planning the Telephone Company's buildings with a view to accommodating switchboards sufficient to handle anticipated growth.

It may here be stated that the size of any exchange (meaning the number of lines) is regulated according to the size of the "B" board, which is where the subscribers' multiple is situated. To avoid a lengthy explanation, it may be stated that it is necessary that an operator at this board should be able to reach and plug into the "jack" of every subscriber connected to the exchange, and it is found that a 10,000 line multiple is the greatest that can be handled by the ordinary girl operator. Therefore, with

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regard to the ordinary manual system of working, the design of the board must be based on the reach of the girl operator of average height.

Naturally, in the suburbs of New York, the demand for service is not so great as in the highly concentrated city, but there is a steady and vigorous demand which must be looked after. This demand is fostered by the "party line" system, which I do not for one moment think would be a success in England. It has, however, this advantage. By reason of the lower cost, local tradespeople are encouraged to become telephone subscribers, as are also local residents. They quickly find out the advantage of the telephone and how much shopping in bad (and also good) weather may be done by telephone, and how they are inconvenienced by a "party line" being busy when they wish to use it, and the natural result is that they arrange for a direct wire. Therefore, although I dislike the party idea and do not think that either I or my neighbours would approve of it, I cannot help but admit that it is a most excellent salesman for the telephone, and, in fact, might justly be termed "the thin end of the wedge."

As already mentioned, there is this steady suburban growth to be cared for, and it is done in a very effective manner. The district is made the subject of a study based on present subscribers and anticipated growth and the telephone centre determined. The nature and dimensions of the equipment to be installed is decided and the important problem of distribution dealt with. In general, overhead distribution is found most satisfactory with as little open wire as possible. Cables are distributed underground to a suitable series of pole-lines and tapped off into cables carried on the poles, a tap being taken from the cable to a junction box on alternate poles and the pole lines running down alternate streets. By this means it is easy to run a "drop wire," consisting of a waterproof twisted pair from any house to the nearest pole junction box. A 25 pair cable will accommodate the subscribers of the average suburban street and is not nearly so much of an eyesore as the open wire method of which I see so much in our suburbs. I cannot say that it would be wise for the G.P.O. to start putting up cables and junction boxes throughout the suburbs at the present time. They will first have to bring the telephone within reach of the small tradesman and average householder and show him how it will increase his business and add to his comfort. If they can do that and run the telephone system on sound business principles, we shall all have cause to be glad that they have taken control of the industry. On the other hand, if they continue to invest a large sum of money in improving transmission between London and Berlin or Geneva, they will seem to be emulating the man who gave largely to foreign missions whilst his next door neighbour died of starvation.

SHOT FIRING BY ELECTRICITY.

At the present day there is no need to emphasise the necessity of taking efficient means to secure safety in that admittedly hazardous operation, unless properly carried out, of shot firing in quarries and collieries. The systems of electric shot firing which have been developed, however, have to a large extent fulfilled the requirements of colliery owners as regards safety, but it will be seen from our further notes that there are still some further possibilities in this direction. In a large number of quarries and collieries there is now to be found an electric lighting and power supply installation, and the apparatus which we mention is designed by Messrs. A. Reyrolle & Company, Ltd., of Hebburn, to operate firing shot circuits from the electric mains of such installations in such positions as are permissible under the Mining Regulations as regards shot firing from electric lighting or power mains. The shot firing apparatus consists of two boxes, a shot firing box shown, and a testing box. The latter simply consists of a cast-iron box, containing two dry cells, a small trembler coil, a telephone receiver, push button, and a small wall plug socket, all connected in series. The twin cable which has been previously connected to the slots is brought up to the box and connection is made by means of a plug which fits into the socket mentioned above, and is of the five-ampere wall plug type with an earth wire attachment

To test the shot firing circuit for continuity the push button or key is depressed, and if the circuit is complete a buzzing sound is emitted in the telephone receiver. Having ascertained that the circuit through the detonators is complete, the plug is now transferred to the shot firing box, shown on the left of the figure. This box is strongly made of cast iron similar to the testing box, and contains a double-pole circuit-breaker, an indicating lamp, a regulating rheostat, and a flicker contact. The lamp gives an indication that there is pressure on the lighting or power means, and the

FIG. 1.

functions of the regulator is to substitute an additional resistance where a small number of shots only is fired. The shot firing box is operated by means of a key, and the procedure is as follows: The double-pole circuit-breaker is first switched in and the key is then transferred to the flicker spindle, a half a turn of which momentarily

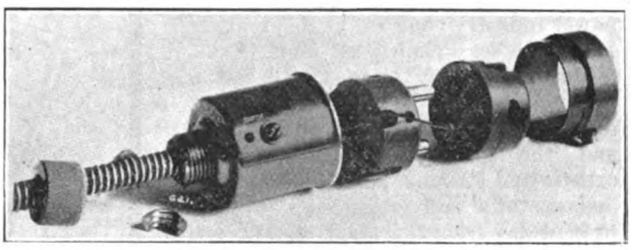

FIG. 2.

completes the circuit through the detonators, thus firing the shots. As a matter of precaution the double-pole switch is automatically tripped a fraction of a second after the contact has been made, and after the shots have been fired the door is closed and can only be opened again by means of a special key in the possession of the shot firer. The purpose of this apparatus is, of course, only for use in driving stone drifts, as according to the Mining Regulations it is illegal to fire shots in coal from the lighting or power mains. The apparatus is, therefore, of distinct interest to all quarry and mine engineers.

It has been said that those engaged in generating and distributing electrical energy, electrical contractors, dealers in electrical supplies, steam, electric, railway and tramway companies, steamship companies, telephone and telegraph companies, Government departments, municipalities, universities, ship-building companies, oil companies, manufacturers who purchase electrical apparatus or supplies for resale in combination with their own products, and such industrial enterprises as mining companies, collieries, cement manufacturers and the like, are entitled to trade terms from manufacturers and factors. Purchasers other than those included in the above groups should not be supplied at trade rates by makers or dealers, but should buy from the contractor or retailer.

As will be seen by an announcement in another column, the municipality of Port Elizabeth, South Africa, desires the services of a mains superintendent experienced in three-wire d.c. systems. The salary is £250, rising to £300 per annum.

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The Evolution of Electrical Publicity.

With the advent of each new year there is a natural tendency to hope, if not to assume, that it is going to be more or less of what our friends on the other side of the Atlantic call in their breezy way a 'banner year" for this or that particular industry. There is certainly such a tendency at the present time to regard 1912 as a period especially favourable to the exploitation of the manifold applications of electricity. At any rate, we are to see the British Electrical and Allied Manufacturers' Association entering upon a year of exceptional activity in the way of advertising, and we have already witnessed the birth of the new monthly publication by means of which the Electric Supply Publicity Committee intends to keep its supporters in touch with its operations and propaganda. These are movements which would no doubt have developed in any event, but it is not unreasonable to assume that they have been to some extent stimulated into an earlier activity by the big publicity campaign which is now being entered upon by the Gas industry, with something like a £20,000 annual subscription behind it. The extensive publicity of the one can only be met by the equally extensive publicity of the other great illuminating and power industry; and so, in this matter, 1912 is to see Pelion piled upon Ossa.

FIG. 1.—DECEMBER, 1907.

Matter of much interest and not a little value might be found in a history of the development of electrical publicity, and the gradual evolution of the artistic and striking posters, showcards and pictorial advertisements of the present day from the staid and (if one may dare to use the term in such a connection) stodgy announcements in the technical press of ten years ago. Of course, in those days we had no metal filament lamps to stimulate the artistic imagination into the production of such arresting designs as the Tantalum "Satisfied Consumer" and "Little Bill," or the General Electric Company's famous Osram poster, or the similarly effective and ingenious showcards and advertisements issued by the manufacturers of Ediswan, Brimsdown, Pope, Z, Efesca, and other lamps. But even in 1902 other developments of far-reaching importance were in progress which would readily have lent themselves to artistic treatment and made their impression on the public mind if only manufacturers had sought the means of accomplishing this end. The fact remains that very few did so, and that the "picture advertisement" is the growth of quite recent years.

Such a study as we have suggested would reveal the fact that quite an exceptional amount of artistic ingenuity has during that period been devoted to the interests of electricity, and in view of such manifestations of the desire of manufacturers in this direction as the recent £100 prize competition organised by Messrs. Siemens Bros. Dynamo Works, Ltd., it is fair to assume that the current year, with its specially devised advertising campaigns, will witness a still more extensive utilisation of the resources of the designer. But it is, of course, an essential condition of advertising of this kind that the designer shall not only be an artist but also one who has made a study of electrical matters. There must be no blunders about the technical details, no solecisms such as that perpetrated a few months ago by a famous illustrated journal, in which a distinguished army officer was shown wearing naval epaulettes. Be it a lamp or a motor or a complicated piece of electrical machinery, if it is to carry an appeal to the technical man, its representation must needs be faithful or the impression it creates is likely to be an unfavourable one. The occasion, however, produces the specialist in this as in other directions, and the electrical trade can count on more than one artist who has made it his business to know and understand the technical side of the work he is required to undertake. With one of these gentlemen the ELECTRICAL ENGINEER had an interesting chat a few days ago, and in the hope of being helpful to manufacturers who in this "banner year" will be planning fresh campaigns, it is proposed to set down the substance of that conversation and to give examples of the kind of work that has been produced and has made its mark.

FIG. 3.—APRIL, 1909.

FIG. 5.—SEPTEMBER, 1910.

The specialist to whom reference has been made is Mr. J. Conway Price, of 151, Fleet-street, E.C., and all the designs here reproduced have been invented and drawn by him. They are given in chronological order by way of indicating the progress which has been made in this particular direction, and of showing how one firm after another has grasped the importance of art in advertising, and has subordinated the descriptive to the pictorial aspect of publicity. Mr. Conway Price has been in the advertising world for some twelve or thirteen years, and it may be interesting to note the successive stages of development which induced him to become a specialist in electrical matters. He began in the advertising department of the Army and Navy Stores, and went from there to Street's, the well-known advertising agents in Piccadilly. The year 1904 saw him in the service of the General Electric Company, where for three years he was assistant to that Company's [illegible]able

FIG. 2.—JUNE 1908.

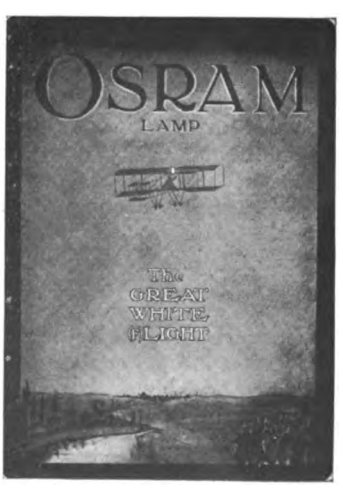

FIG. 4.—MAY, 1910.

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FIG 6.—DECEMBER 1910.

publicity manager, Mr. H. C. Palmer. In 1907 he started in business for himself. In those days the advertisement copy of most electrical firms consisted for the most part of a wood-cut or half-tone reproduction of some specific article accompanied by a few words in plain, bald type. It was Mr. Price's belief that methods which had been so successfully applied in other directions would be no less effective in connection with electrical manufactures, but for six months or so he found it very difficult to convert advertisers to this point of view. Their attitude seemed to be that electricity was a very serious matter, and demanded the baldest and most unimaginative treatment. But one day he called on Mr. Justus Eck, of the Union Electric Company, and showed him a design which he had called "Law and Order" (Fig. 1). Mr. Eck, as a keen business man, appreciated the force and cleverness of the drawing, and it soon made its appearance as a full page advertisement in the technical press. That was the beginning of things for Mr. Conway Price, and it confirmed him in his original idea of specialising in electrical work.

The idea "caught on." Mr. Schmahl, of the Armorduct Manufacturing Company, Ltd., accepted the design shown in Fig. 2, and then Cryselco, Ltd., took up the tale. There soon followed the design shown in Fig. 3—the Crompton-Blondel arc lamps along the Victoria Embankment with the Houses of Parliament and Big Ben and Westminster Bridge in the middle distance; and then the General Electric Company's Osram lamp, the "Great white (f) light," (Fig. 4) hot upon Grahame-White's aeroplane flight from London towards Manchester. This device of hitting upon the topic of the moment and linking it up with electrical announcements became immediately popular. When the famous "guarantees" were on everybody's lips in and out of Parliament, out came Messrs. Nalder Bros. & Thompson's striking full page advertisement (Fig. 6), in which Mr. Asquith is shown at the table of the House of Commons—"Gentlemen,—You ask for Guarantees—the N.C.S. 'Ohmer' carries a free guarantee!" Then on the heels of the Royal Proclamation came another arresting announcement (Fig. 9) from the same firm—"To all whom it may concern. N.C.S. Know ye by these presents that when these letters are discovered upon Electrical Measuring Instruments of any description, such instruments so marked represent the highest grade of workmanship and material and are guaranteed for Accuracy and Reliability." By this time other large and important advertisers had come into the scheme—the Foster Engineering Company, the Sun Electrical Company, Simplex Conduits, Limited, the Electrical Company, Ltd., Messrs. Elliott Bros., Messrs. Everett, Edgcumbe & Company, the "Gral" lamp, the British Thomson-Houston Company, the Globe arc lamp, and numerous others. The policeman designed in 1907 and silhouetted against Mr. Justus Eck's Excello arc lamps had set the ball rolling and it has been rolling at a continually increasing pace ever since.

FIG 12.—OCTOBER 1911.

The Electrical Exhibition at Manchester in 1908 produced a noteworthy crop of designs from Mr. Price's pen, but it was the Olympia show of last autumn that proved most fertile in this particular field. We give a specimen of the Sterling Telephone & Electric Company's advertisement (Fig. 11), which proved to be a most attractive page, though a good deal of its effect is necessarily lost in the reduction. Following it is a daring adaptation (Fig. 12) of the Witches broomstick, applied to the electric vacuum cleaner of "Magic" Appliances, Ltd., which affords a very noteworthy example of what may be accomplished in the way of effective advertisement deisgn. When the reader has noted this design and all that it conveys, he should turn back once more to Fig. 2, "The Witton Grip," and he will get the key to the artist's method—the conception of one dominant note which instantly draws the eye to the announcement which the advertisement conveys. Fig. 13 shows a variant of the familiar Satanic showcard of Messrs. Falk, Stadelman & Company, Ltd., and the last two reproductions given represent what are, perhaps, the most attractive designs ever issued on behalf of the Brimsdown lamps. The advertisement shown in Fig. 14 is especially striking, for the print behind the torn page (though nothing but a microscope will reveal it in our block) dealt insidiously with Brimsdowns, and in the original full-page print it is impossible to avoid reading it. The torn page is not, of course, a new idea, but it has rarely been put to more eye-compelling use. The last reproduction cleverly combines some showcards with which we are all familiar—John Bull carrying the Brimsdown lamp, the "see things in a better light" poster, and the

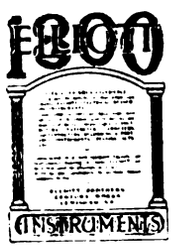

FIG. 7.—FEBRUARY 1911.

FIG. 8.—MARCH 1911.

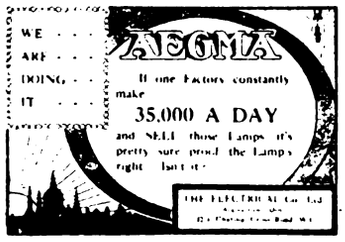

FIG. 10.—AUGUST 1911.

FIG. 9.—JUNE 1911.

FIG. 11.—SEPTEMBER 1911.

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"After Sundown, Brimsdown," being peculiarly effective.

The outcome, more or less directly, of the stress of competition, pictorial advertisements such as those here touched upon, are a valuable asset to the manufacturer. It is the mainspring of every business, not necessarily to proclaim "my goods are the best," but so to frame the announcements concerning those goods that the prospective buyer's attention is arrested and his interest aroused. It is on the records that some two years and a half ago, a wholesale watch manufacturer, by means of a skilfully drawn advertisement, sold through the post fifteen thousand oxydised metal watches at twenty-one shillings each. They were good watches, of their kind, but their factory cost at the outside could scarcely have exceeded six shillings each. Yet a bold advertisement netted the manufacturer a profit of something like £11,250, less the cost of the advertisement and the postage. We are not suggesting that anything on such a gigantic scale could be done in the electrical world, but the illustration is a poignant one nevertheless, and the moral it conveys for 1912 is, in the first place, advertise, and in the second place advertise artistically.

FIG. 13.—NOVEMBER 1911.

It may, perhaps, be desirable to add, in order to remove any misapprehension on the part of our readers, that these notes have been compiled with the single purpose that they may prove helpful to the electrical trade in a year which promises to be one of exceptional activity from the publicity point of view, and Mr. Conway Price's work has only been chosen by way of illustration because it so aptly illustrates a point of view which we believe to be one of conspicuous value. If, incidentally, it shows that within a period of five years a young and previously unknown artist can build up a large business by making a speciality of electrical advertising, that fact simply serves to emphasise our contention that this particular phase of electrical enterprise demands the earnest attention of all who have at heart the best interests of an industry which is to-day face to face with a gas advertising campaign which promises to develop on a scale infinitely more colossal than anything that has yet been attempted in connection with that business. We have endeavoured to give in collected form by means of some fourteen or fifteen specific illustrations an idea of what *has* been done in connection with the electrical trade, and we hope in a future issue to deal with the special work of the Electric Supply Publicity Committee. Meanwhile, it remains for the electrical trade as a whole to show what *can* be done.

FIG.1 4.—NOVEMBER 1911.

FIG. 15.—DECEMBER 1911.

The "Synchron" Apparatus.

The "Synchron" Life-Saving Apparatus for the Promotion of Artificial Respiration in cases of Electric Shock, Drowning, Mine Gas Poisoning, etc., is now being manufactured for us in London and Birmingham under expert personal supervision, and all orders are being filled in rotation as speedily as we can obtain supplies of castings.

Sets of apparatus have already been ordered for the following Power Stations:

LONDON.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LTD.
BROMPTON AND KENSINGTON ELECTRIC SUPPLY COMPANY, LTD.
WEST HAM BOROUGH COUNCIL ELECTRICITY DEPT.
POPLAR BOROUGH COUNCIL ELECTRICITY DEPT.
NORTH METROPOLITAN ELECTRIC POWER SUPPLY COMPANY, LTD.
ST. PANCRAS BOROUGH COUNCIL ELECTRICITY DEPT.
THE CHARING CROSS WEST END AND CITY ELECTRICITY COMPANY, LTD.
THE METROPOLITAN ELECTRIC SUPPLY COMPANY, LTD.
STEPNEY BOROUGH COUNCIL ELECTRICITY DEPARTMENT.
ISLINGTON BOROUGH COUNCIL ELECTRICITY DEPARTMENT.
SOUTH METROPOLITAN ELECTRIC TRAMWAY AND LIGHTING COMPANY, LTD.

COUNTRY.

GLASGOW CORPORATION ELECTRICITY DEPARTMENT.
CLYDE VALLEY ELECTRIC POWER COMPANY, LTD.
MANCHESTER CORPORATION ELECTRICITY DEPARTMENT.
LANCASHIRE DYNAMO AND MOTOR COMPANY, LTD.
THE BRITISH THOMSON-HOUSTON COMPANY, LTD.
MESSRS. HARLAND & WOLFF, LTD., Belfast.

ABROAD.

MESSRS. ANDREW MOIR & COMPANY (for South Africa).
MESSRS. STRACHAN OSWELL & COMPANY (for South Africa).
THE BAKHTIARI OIL COMPANY, LTD.
THE ANGLO-PERSIAN OIL COMPANY, LTD.

OTHER ORDERS.

THE MERSEY DOCKS AND HARBOUR BOARD.
MESSRS. H. SIMONIS & COMPANY, Fire Engineers
MESSRS. HENRY MORGAN & COMPANY.

TENDERS, ETC.

BUENOS AYRES AND PACIFIC RAILWAY COMPANY, LTD. (12 machines).
VICTORIA FALLS AND TRANSVAAL POWER COMPANY, LTD.

Many of the orders referred to are for 6 and 12 machines and upwards.

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The Father of Electrical Science.

William Gilbert of Colchester.

Notes, biographical and otherwise, of the early philosophers, writers, and navigators mentioned by him in "De Magnete." Some curious observations and opinions especially concerning the loadstone and several objects magnetical.

(*Continued from page 750*).

FALLOPIUS, GABRIELLUS (1523–1562), famous Italian physician, who, according to Cuvier, was the restorer or rather the creator of anatomy, in conjunction with Vassalli and Eustachi, during the sixteenth century. His principal work is *Observationes Anatomicae*, the others alluded to by Gilbert being *De Simplicibus Medicamentis* and *De Compositione Medicamentorum* wherein are given especially his views regarding the medicinal power of both iron and loadstone.

FERNELIUS, JOANNES FRANCISCUS (1497–1558), celebrated French physician, called the modern Galen, wrote quite extensively on different subjects but is best known by his *De Abditis Rerum Causis*. Gilbert refers to the latter saying that "Fernel finds in the loadstone a hidden and abstruse cause, which cause is celestial and he does but explain the unknown by the more unknown."

FICINO, MARSILIO (1433–1499) was the physician of Cosmo de Medici and one of the leading scholars of the Renaissance. He was celebrated as the most distinguished translator of Plato and as the reviser of Platonic philosophy in Italy. Gilbert says that "Ficinus chews the cud of ancient opinions and, to give the reason of the magnetic direction, seeks its cause in the constellation Ursa. Ficinus writes, and Merula copies, that in the loadstone the potency of Ursa prevails and hence it is transferred into the iron."

FRACASTORIO, HIERONYMO (1483–1553), Italian physician and one of the most learned men of his day. He instituted many important astronomical observations, and it was he and Peter Appian who, it is said, first made known in Europe the curious fact that comet's tails are always turned away from the sun, so that their line of prolongation passes through its centre. Gilbert alludes to Fracastorio (Bk. I, Ch. 1: Bk. II, Ch. 2, 4, 24, 38, 39: Bk. IV, Ch. 1) and especially to his *De Sympathia*, an important work in which universal attraction, as well as magnetic and electric motion, is attributed to an imponderable principle, and wherein reference is made to peculiar forms of loadstones as well as to Fracastorio's belief in the existence of magnetic mountains attracting objects of magnetic iron.

GALEN—GALENUS—CLAUDIUS (130–210), is, admittedly, the most celebrated of ancient medical authors, and is frequently referred to by Gilbert. Allusion is made more particularly to Galen's *De Simplicium Medicamentorum* and *De Naturalibus Facultatibus* wherein he recognizes the medicinal virtue of loadstone and its natural power of attracting iron. He says that Galen admits, in all, three kinds of attraction in nature: first, the attraction exercised by those bodies which attract by an elemental quantity—heat, to wit—secondly, by those which attract by the in-rush into a vacuum; thirdly, by those which attract through a property pertaining to their entire mass: all of these three kinds being enumerated by Avicenna and several others.

GAURICUS, LUCAS (1476–1558), Italian mathematician and astronomer, one of whose pupils was Julius Cæsar Scaliger, is the author of twenty-one different works, of which the best known were published in 1540, 1546, 1552, 1560. Gilbert says Lucas held that beneath the tail of Ursa Major is a loadstone and that he assigns the loadstone (as well as the sardonyx and the onyx) not only to the planet Saturn but also to Mars (with the jasper, diamond and ruby) so that the loadstone according to him is ruled by two planets.

GEBER—YEBER—AL TARSUSI—who lived in the eighth century A.D. and to whom Gilbert alludes in Bk. I, Ch. 7, is the earliest of the great Arabian chemists or alchemists. Rhazes and Avicenna call him "the master of masters," and, by the author of *The Lives of Alchemist Philosophers*," he is designated as "the prince of those alchemical adepts who have appeared during the Christian era," as many as five hundred different alchemical works have been attributed to him.

GEMMA, CORNELIUS, son of the celebrated mathematician Gemma Frisius, a well known physician of Louvain (1535–1597), is the author of numerous books, the most important of all being the *Cosmocrit*. . . . published during 1575. To the latter, Gilbert makes reference in his second book adding: "Cornelius declared that the loadstone draws iron to itself by invisible rods, and to this opinion he tacts on a story of the sucking-fish and the catablepas."

GIOJA—GOIA—FLAVIO, said to be an Italian pilot born at Positano, near Amalfi, end of the thirteenth century, is reported by Venanson to be the real inventor of the mariner's compass. Without going very much into the question of the real discover of the compass—although he states that the Melfitani first used it in Mediterranean waters and alludes to Levinius Lemnius's report of its antiquity—Gilbert, in his first chapter, says: "The people of Melfi in the kingdom of Naples are reported to have first constructed a mariner's compass: and, as Flavius Blondus states, the townsmen do not without reason boast they were so taught by one Gioja, a fellow citizen in the year 1300." As we now know, the pretended invention by Gioja had many years before been devised by Petrus Peregrinus.

GONZALUS OVIEDUS-GONZALO FERNANDEZ DE OVIEDO Y VALDES (1478–1557), was one of the earliest historiographers of the New World, whose principal work, *Summario de las Indias Occidentales*, 1525, according to Gilbert contains the earliest mention of the fact that in the meridian of the Azores there is actually no variation.

GOROPIUS, HENRICUS BECANUS (1518–1572), Belgian savant who practised medicine at Antwerp and who we are told by Gilbert "ascribes the variation of the compass to the Cimbri or Teutons on the ground that the thirty-two names of the winds thereon inscribed are pronounced in German by all mariners whether they be British, or Spaniards, or Frenchmen."

GROTIUS, HUGO, the latinized form of the Dutch De Groot, a great theologian and jurist (1583–1645) whose extra ordinary precocity so much attracted Joseph Sealiger that he undertook to direct his studies at the Leyden University. He is twice named by Gilbert in Bk. IV, Ch. 9, which treats of the finding of terrestrial longitude from variation, and also in conjunction with Simon Stevinus whose great work on navigation Grotius was able to translate into Latin.

HARIOT, THOMAS (1560–1621) is one of the learned Englishmen alluded to by Gilbert, at the end of the first chapter, Bk. I, of *De Magnete*, as having on long sea voyages observed the differences of magnetic variation. Hariot was a mathematician and astronomer whose miscellaneous works embrace treatises on magnetism, mechanics, etc., and whose account of a voyage to Virginia appeared in *Hakluyt's Voyages*. The other navigators named by Gilbert are Robert Hues, Edward Wright and Abraham Kendall, the last named one being sailing master under Sir Robert Dudley. Others, he says, have invented magnetic instruments and published ready methods of observing which are necessary for mariners: as William Borough, in his "Variation of the Compass," William Barlowe, in his "Supplement" and Robert Norman in his "Newe Attractive."

(*To be continued.*)

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Technical Problems and their Solution.

QUESTIONS AND ANSWERS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways, and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for the next best, but in the case of two replies adjudged to be of equal merit, these two sums may be added together and divided. Replies should reach the office within seven days of the appearance of the questions.

QUESTIONS.

Problem No. 1269.—It is required to measure insulation resistances varying from one megohm to 50,000 megohms, using a galvanometer of 150 ~ sensitivity and 800 ohms resistance. State, with reasons for preference, which of three universal shunts having a total resistance of 100,000, 10,000, and 1,000 ohms respectively, would be most suitable for use with this galvanometer for obtaining the required measurements. "BICKNOLLER."

Problem No. 1270.—When using a universal shunt in conjunction with a galvanometer it is best to have the total resistance of the universal shunt not greatly differing from that of the galvanometer, for if the resistances of galvanometer and shunt are disproportionate a loss of sensitiveness occurs. Explain the reason for this.—"BICKNOLLER."

Problem No. 1271.—Explain—with theoretical justification—a method of measuring fault resistances, applicable to 3-phase or 2-phase 3-wire networks. Simplicity is important.—"QUERIST."

Problem No. 1272.—On a three-phase circuit of shaft cables there are two pumps; one a turbine the other a three-throw. Starting up the three-throw causes a wattmeter coupled to one phase (balanced load) to revolve in its correct direction. Starting the turbine one now causes the disc to slow down, stop, and revolve in the opposite direction. Turbine works at half normal head. Pressure coil of wattmeter is connected to a potential transformer phase to neutral.—"P. F."

ANSWERS.

Problem No. 1268.—A three-phase 50 ~ 500 volt, 25 h.p. motor with wound rotor is connected up to 400 volt 50 ~ mains. Full load r.p.m. on 500 volts = 1,450. On 400 volts the maximum full load speed was 1,360 r.p.m. The rotor winding and slip rings got very hot. On short-circuiting the slip rings (carbon brushes, no short-circuiting device) with a copper bar the speed became 1,420 r.p.m. Now, an exactly similar squirrel-cage motor ran at 1,450 r.p.m., although on 400 volts instead of 500. Will someone explain the reason of the unusually large slip of the first motor?—"ROTOR."

Reply to No. 1268 (*awarded* 10s.).—The explanation of the phenomenon observed by "Rotor" is very simple and at the same time so instructive (in that it involves an investigation into the first principles of the induction motor) as to deserve careful attention.

In any piece of electrical apparatus when mechanical motion is obtained, the principle of action lies in the well known fact that two electromagnetic fields either attract or repel one another. If two such fields are strong enough—and if the construction of the particular piece of apparatus allows of it—the resultant force may be so powerful as to produce relative motion of the seats of origin of these fields. For instance, in the ordinary direct current motor, rotation of the armature is caused by the repellent action of the lines of force set up by the current generated in the armature and those set up by the current in the field. In D.C. machines the strength of these forces of repulsion depends only on the strength of the interacting fields and their disposition relative to one another in space. In A.C. machines, on the other hand, another very important factor comes into operation—that of the relative phases of the interacting fields. The force that comes into action when two alternating fields react on one another depends to a very large extent on their phase difference. For instance, two fields which reach their maximum and minimum values simultaneously, exert a definite repellent or attractive action through each successive cycle, whereas if these two fields differed in phase by say 90°, the resultant force would be zero. For although the force would exist instantaneously, it would change in sign and sense with each cycle, with the result that its resultant value, taken over a definite period of time, would be zero.

Taking the principles summarised above we can at once explain the phenomenon observed by "Rotor" by applying them to the induction motor. The induction depends for its action upon the force of repulsion exerted by the fields produced by the rotor currents and the main rotating field. This force, in fact, is proportional to the product of these two quantities, i.e., to the rotor current and the rotating field. If we decrease one of these quantities we must increase the other if the same torque as before is to be maintained. Assuming that the frequency is fixed, the strength of the rotating field depends entirely on the voltage applied. If, therefore, the stator voltage is reduced, the rotor current (and, consequently, the rotor voltage) must increase if the torque is to be maintained. This increase of rotor voltage can only be obtained by an increased slip, i.e., by a drop in speed. This consequently drops under these conditions to a value at which the increased rotor currents acting on the increased rotating field exert the desired torque. Under these conditions, the rotor current may reach such a high value as to dangerously heat up the rotor conductors. This is, in fact, actually what "Rotor" observed. This action, of course, applies to both squirrel cage and slip ring motors.

We will now investigate how the latter type of motor drops more in speed than the latter under given conditions. From their very nature, wound rotors evidently have bigger self induction than plain squirrel cage rotors, and they also have a bigger resistance. The total impedance of a wound rotor, therefore, is bigger than that of a squirrel cage rotor, and, in consequence, to produce a given rotor current in the former type, a bigger rotor voltage is necessary, and this, as has already been pointed out, means a bigger drop in speed. But besides requiring a bigger slip to produce a given value, the rotor current in a slip ring motor is also less effective than an equal current in a squirrel cage motor, in that the self induction of the former type is (as has already been pointed out) greater than that of the latter. The consequence is that a bigger phase difference exists between the rotor current and the rotor voltage in the former type, i.e., between the rotor current and the main rotating field, with the result that they are less effective. The resultant repellent force, therefore, decreases, and in order that it may be increased so as to still exert the desired torque a still larger rotor current is necessary and the speed drops still further. It must also not be forgotten that as the speed falls, the frequency of the rotor currents increases, thus increasing the rotor reactance. This, in turn, obviously increases the ineffectiveness of the rotor current. Owing to this effect of decreasing the effectiveness of the rotor current, besides their numerical values, a small self induction in the rotor current often necessitates a very big slip in induction motors when working under load. Obviously, a rotor with closed slots will greatly aggravate this difficulty, as the rotor leakage will then be increased. This, in effect, will increase the rotor self induction.

In the case under question the sudden increase of speed from 1,360 r.p.m. to 1,420 r.p.m., when the slip rings are short-circuited appears to suggest that there was some external resistance in the rotor circuit, such as, for instance,

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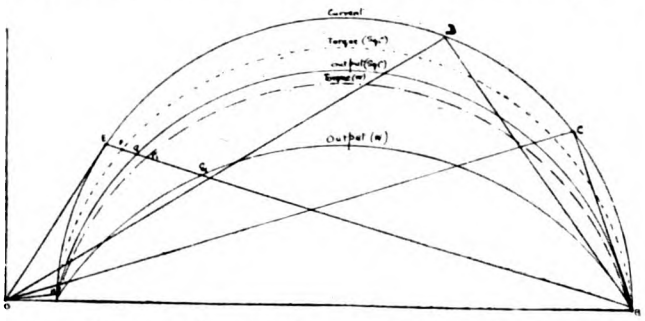
a comparatively long length of cable between the slip rings and the starter.

It would be interesting if " Rotor " had told us what was the speed of the squirrel cage motor with a stator voltage of 500. I should imagine this would have been of the order of 1,470 r.p.m.—" OCTAVUS."

Further Reply to No. 1268 (*awarded* 5*s.*).—The cause of the large difference in the slips of the two rotors tried is undoubtedly the comparatively large difference in the resistances of the rotor circuits in the two cases. The number of revolutions a rotor will fall behind those of the stator fields depend entirely on the relation of the reactance to resistance of the rotor conductors. In a rotor of very low resistance the reactance is the governing factor, as it causes the rotor currents to lay a great deal behind the stator flux, consequently very little slowing down of the rotor will lead to large currents in its conductors, and these make the torque conditions very strong. This high rotor reactance has the disadvantage, however, of lowering the power factor and also making the starting conditions bad, because of the extensive reaction and weakening of the stator flux, resulting in a rush of stator current.

Now, if we insert even a small resistance in series with the rotor conductors or increase their resistance, we neutralise some of the rotor reactance and thus reduce the lag of the currents, so that when running under the same load conditions as previously we must have increased slipping behind of the rotor conductors, in order to get a greater E.M.F. in them to get currents to obtain the requisite



torque. But now the rotor flux would not weaken the stator field anything like so much, and in consequence our power factor and starting conditions are better, but, owing to the extra heat losses we have got in the rotor, our efficiency would be less.

If the requisite tests were taken on these two rotors and a Heyland diagram drawn from the results it would again show us the difference of the slips in the two cases. Firstly, we should find a striking difference in the position of the two short circuit current vectors, this difference being due to the different impedances of the two rotors. These vectors would occupy positions as shown in Fig. 1. O.C. would be the vector with the short-circuited rotor and O.D. will be that with the wound rotor, O.E. and O.H. being the full load and open circuit vectors respectively. Now as the lines joining these points, C. and D., with the extremity of the semi-circle B. are tangents to the output circle, it will be seen how the position of the short-circuit current vector will affect the whole diagram with respect to torque, slip and efficiency, for the inclination of this line (D.B. or C.B.) influences the position of the torque circle. For the short circuited rotor the torque circle would be as shown dotted, and as chain dotted for wound rotor. Then in the former case the slip at full load would be proportional to F.G. and in the latter case to F_1G_1.

We thus see how great an influence the resistance of the rotor conductors has upon the slip. Let us consider this as regards the two rotors tried. In the wound rotor the conductors would not be quite as large in cross section as those of the squirrel cage, we will also have the resistance of cables to slip rings, brush contacts, external cable and starter contacts, all these will go to make the total resistance in the rotor circuit of the wound rotor some two or three times that of the squirrel cage rotor.

It is assumed that the iron parts of the two rotors are alike and that the airgaps are equal.

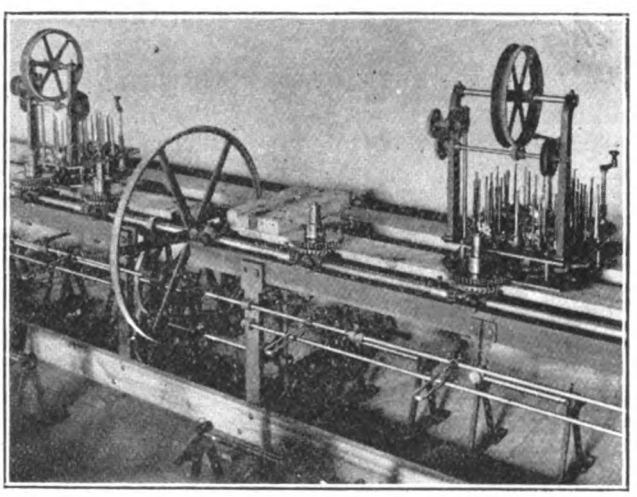
We must remember that on 400 volts the stator iron is unsaturated and the field will be easily weakened when the reaction of the rotor comes into operation, and the motor will soon reach an unstable state. If we had applied 500 volts to the stator terminals and tried both rotors we should in all probability have got the wound rotor to run up to its rated speed of 1,450 r.p.m., but we should have been able to get 1,475 to 1,480 r.p.m. out of the short-circuited rotor at full load on account of its lower resistance.

Now weakening the field by reducing the volts to 400 reduces the whole magnetic strength of the machine, and it will affect the two rotors to a similar extent. Thus we see that the squirrel cage rotor drops to 1,450 r.p.m. and the wound rotor to 1,420 (when we have a good connection at the slip rings). As demonstrated in the experiment reported in the question, any bad contact at the slip rings, brushes, cable or starter contacts will be increased resistance and lead to more slip and larger rotor currents and thus cause heating. This is fully borne out by the lower slip obtained when the slip rings are short-circuited by a copper bar, and if this rotor were fitted with revolving jaws and knives and a good short-circuit contact made, the slip might be still further reduced.

The writer has come across several cases where short-circuited rotors have developed large slips and heating due to the rotor conductors and connections to the end rings being reduced in cross section by the action of a chemical atmosphere the motor was working in.—" J. E. R. R."

A MOTOR-DRIVEN BRAIDING MACHINE.

The illustration of a motor-driven braiding machine which is shown herewith is interesting for two or three reasons. In the first place, having regard to the intimate relation of electricity to cable manufacture, the application of electric motive power is an eminently suitable thing, but, unhappily, it is not always adopted. This example of up-to-date design is, therefore, an indication of the way in which electricity for power purposes is finding its way into all branches of industry. In the second place it is a concrete example of the fact that in spite of the pushfulness of the German manufacturer and the German traveller, they do not always get their own way. This machine was made in America by the Textile Machine Works, of Reading, Pennsylvania, for use by a German firm of cable makers. The illustration does not show the motor actually in place



ELECTRICALLY DRIVEN BRAIDING MACHINE.

but two cross pieces will be noted on the bench immediately in front of the large spur gear, and the motor when in position is placed on these cross beams, the power being transmitted from the motor through a pinion and the large gear shown to the main driving shaft, which in turn transmits power to the braiders themselves through driving sets composed of bevel gears and spur gear attached to the braiders. These braiders are single deck, 24 carrier, wire braiders suitable for braiding over rubber covered wire and cables. It may be added that in the United States cable insulating and braiding machinery is very largely electrically driven, a number of the larger insulated wire plants in that country being equipped with gear similar to that illustrated, and some of these plants have found their way to this country. In view, therefore, of the energetic means which are nowadays taken to push alternative forms of power, this application of electricity is both interesting and instructive.

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A Year's Progress.

A PERSONAL NOTE TO ADVERTISERS ON THE ADVANCE OF THE "ELECTRICAL ENGINEER."

In this, our first number for the New Year, it may not be out of place to say a few words with regard to the recent progress of the ELECTRICAL ENGINEER, now in the 29th year of its existence.

Most of our readers are no doubt aware of the fact that upwards of a year ago the journal came under entirely new ownership, and that almost simultaneously a change was made in the editorial control and management. The new owners immediately set about the task of making the ELECTRICAL ENGINEER an indispensable journal for the electrical engineering and manufacturing industry, with results extremely gratifying to all concerned. In a note on this subject, published in September last, the following reference was made to this policy:

> It is the desire of the proprietors of the ELECTRICAL ENGINEER to make it one of the most popular and widely read technical journals in this country. With that end in view, many new features have been introduced and old ones improved and brought up to date, and the services were secured of an exceptionally able staff of contributors in order that every phase of electrical activity might adequately be represented. The result of this policy has been an increase in the circulation and influence of the journal so great as to warrant its conductors in embarking upon a new development which otherwise would have been impracticable.

The development thus referred to was the reduction in the price from Threepence to Twopence; a policy which met with some criticism at the time, but one which has been amply justified by results. Since September 22, when the reduction came in force—contemporaneously with the opening of the Electrical Exhibition at Olympia—the circulation of the ELECTRICAL ENGINEER has

INCREASED BY OVER 40 PER CENT.

and continues to increase week by week.

A remarkable proof of the character of this circulation has been afforded in connection with the "Synchron" Life-Saving Apparatus—the ingenious and, indeed, almost epoch-making invention for the restoration of animation by mechanical means in cases of electric shock, mine gas poisoning, drowning and other forms of asphyxia — which the ELECTRICAL ENGINEER has introduced into this country. From the first reference to this apparatus which appeared in these columns we have been inundated with inquiries and orders, and within three months thousands of such inquiries reached these offices from all parts of the Continent of Europe, from Australia, New Zealand, South Africa, the Soudan, Egypt, India, Canada and the United States, thus amply justifying the claim, not only that the ELECTRICAL ENGINEER has a World-wide Circulation, but that it is a circulation among the Right Class, for the inquiries have come from firms and incorporations representing Every Phase of the Electrical Industry.

That is one instance. Here is another equally gratifying in its way. It is in the form of a letter from a new advertiser, who writes:

> *You will be pleased to learn that my advertisement in your columns has brought me in three weeks upwards of 400 inquiries.*

And here is one more. Reference was made in our news columns to an electrical speciality embodying a wholly novel principle. Before the next issue of the ELECTRICAL ENGINEER had gone to press more than 100 letters had been received requesting us to put the writers in touch with the manufacturers, which, of course, we had great pleasure in doing. A little later we received a letter from the manufacturers in the course of which they said:

> *We are very much obliged by your good offices in this matter and have pleasure in informing you that the orders received through your instrumentality will keep our works busy for several weeks to come.*

These facts speak for themselves, and we venture to think that no better tribute could be paid to the value of the ELECTRICAL ENGINEER as an advertising medium for British manufacturers who wish materially to increase their business.

ELECTRIC LIGHTING PROVISIONAL ORDERS, SESSION, 1912.

The following is the full official list of applications for Electric Lighting Provisional Orders deposited with the Board of Trade in respect of the Parliamentary Session of 1912. In the details here given particulars of order and area are first enumerated, the names of the promoters of the order follow, and in brackets are given the names of the Parliamentary Agents.

Abercarn Electric Lighting (Amendment) Order: Urban District Council (Messrs. Lees & Company, Bridge-street, Westminster, S.W.).

Abingdon Electric Lighting Order. The Borough of Abingdon: Corporation (Messrs. Lees & Company, Bridge-street, Westminster, S.W.).

Altrincham and Bowden Electric Lighting (Extension) Order. Portion of the Urban District of Hale, the Parishes of Ashley, Ringway and Baguley, portion of the Parish of Dunham Massey, and portion of the Parish of Timperley all in the Rural District of Bucklow: Altrincham Electric Supply, Limited (Messrs Sherwood & Company, 22, Abingdon-street, Westminster, S.W.).

Ardsley Electric Lighting Order. The Urban District of Ardsley: Electrical Distribution of Yorkshire, Limited (Messrs. Torr & Company, 2, Millbank House, Westminster, S.W.).

Aylesbury Electric Lighting Order. The Urban District of Aylesbury: Urban District Council (Messrs. Rees & Freres, 5, Victoria-street, Westminster, S.W.).

Bedwas and Machen Upper Electric Lighting Order. The Parishes of Bedwas and Machen Upper in the Rural District of Saint Mellons: South Wales Electrical Power Distribution Company (Messrs. W. & W. M. Bell, 3a, Dean's-yard, Westminster, S.W.).

Biddulph Electric Lighting Order. The Urban District of Biddulph: The Urban District Council (Messrs. Sharpe & Company, 9, Bridge-street, Westminster, S.W.).

Bingley Urban District Council Electric Lighting Order. The Urban District of Bingley: Urban District Council (Messrs. Dyson & Company, Caxton House, Westminster, S.W.).

Birstall Electric Lighting Order 1901 (Amendment) Order: Urban District Council (Messrs. Baker & Company, 54, Parliament-street, Westminster, S.W.).

Bognor Electric Lighting Order. The Urban District of Bognor: Mr. William Tate (Messrs. Wyatt & Company, St. Stephen's House, Westminster, S.W.).

Burnham Electric Lighting Order. The Urban District of Burnham, the Parish of Berrow and portion of the Parish of Brent Knoll in Rural District of Axbridge: Urban District Council (Messrs. Torr & Company, 2, Millbank House, Westminster, S.W.).

Burnley Electric Lighting (Extension) Order. The Parish of Reedley Hallows in the Rural District of Burnley: Corporation (Messrs. Lewin Gregory & Anderson, 2, Millbank House, Westminster, S.W.).

Cheltenham (Extension) Electric Lighting Order. The Parishes of Leckhampton, Prestbury, Swindon, Badgeworth, Shurdington, and Up Hatherley in the Rural District of Cheltenham, and the Parishes of Bishop's Cleeve, Woodmancote and Southam and Brockhampton in the Rural District of Winchcombe: Corporation (Messrs. Ellis & Ellis, 10, Little College-street, Westminster, S.W.).

Darton and District Electric Lighting Order. The Urban District of Darton, and the Parish of Cawthorne in the Rural District of Penistone: Electrical Distribution of Yorkshire, Limited (Messrs. Torr & Company, 2, Millbank House, Westminster, S.W.).

Doncaster Corporation Electric Lighting (Extension) Order. The Urban District of Wheatley: Corporation (Messrs. Sherwood & Company, 22, Abingdon-street, Westminster, S.W.).

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Dorchester Electric Lighting Order. The Borough of Dorchester: Messrs. J. & W. Purves (Messrs. Lees & Company, Palace Chambers, Bridge-street, Westminster, S.W.).

Goole Electric Lighting Order. The Urban District of Goole: Mr. James William Speight (Messrs. Butterworth & Company, Whitehall House, Charing Cross, S.W.).

Goole and District Electric Lighting Order. The Urban District of Goole and the Parishes of Rawcliffe, Airmyn and Hook in the Rural District of Goole: Electrical Distribution of Yorkshire, Limited (Messrs. Torr & Company, 2, Millbank House, Westminster, S.W.).

Great Harwood Electric Lighting Order. The Urban District of Great Harwood: Urban District Council (Messrs. Butterworth & Company, Whitehall House, Charing Cross, S.W.).

Greetland Electric Lighting Order. The Urban District of Greetland: Urban District Council (Messrs. Robbins & Company, 218, Strand, W.C.).

Holmfirth Electric Lighting Order. The Urban Districts of Holmfirth and Netherthong: Urban District Council of Holmfirth (Messrs. Dyson & Company, Caxton House, Westminster, S.W.).

Hoyland Nether Electric Lighting Order. The Urban District of Hoyland Nether: Urban District Council (Messrs. Durnford & Company, 315, Caxton House, Westminster, S.W.).

Hoyland Nether and District Electric Lighting Order. The Urban Districts of Hoyland Nether, Wombwell, and Worsborough: Electrical Distribution of Yorkshire, Limited (Messrs. Torr & Company, 2, Millbank House, Westminster, S.W.).

Ilkley Electric Lighting Order. The Urban District of Ilkley and the Rural Parish of Middleton in the Rural District of Wharfedale: Urban District Council (Messrs. Butterworth & Company, Whitehall House, Charing Cross, S.W.).

Launceston Electric Lighting Order. The Borough of Dunheved, otherwise Launceston: Launceston and District Electric Supply Company, Limited (Messrs. Deacon, Gibson, & Marriott, 9, Great St. Helens, E.C.).

Linlithgow and Falkirk District Electric Lighting Order. The Municipal Burghs of Linlithgow, Bathgate, and Armadale, and the Parishes of Linlithgow, Borrowstounness and Carriden, Bathgate and Torphichen in the County of Linlithgow (except such part of the Parish of Borrowstounness and Carriden as lies within the Municipal Burgh of Barrowstounness), the Municipal Burgh of Kilsyth and the Parishes of Kilsyth Denny Dunipace Falkirk Larbert Grangemouth Slamannan and Muiravonside in the County of Stirling (except such parts of any of these Parishes as lie within the Municipal Burghs of Falkirk Denny and Dunipace and Grangemouth) and the Parish of Cumbernauld in the County of Dumbarton: Mr. George Balfour (John Kennedy, 25, Abingdon-street, Westminster, S.W.

Llanelly Electric Lighting (Extension) Order. The Urban District of Burry Port and portions of the Parishes of Pembrey, Llanelly (Rural) and Llangennech in the Rural District of Llanelly: Llanelly and District Electric Lighting and Traction Company, Limited (Mr. John Kennedy, 25, Abingdon-street, Westminster, S.W.).

Llantwit Fardre Electric Lighting Order. The Parish of Llantwit Fardre and a portion of the Parish of Llantrisant: South Wales Electrical Power Distribution Company (Messrs. W. & W. M. Bell, 3a, Dean's-yard, Westminster, S.W.).

Newton-in-Makerfield Electric Lighting Order. The Urban District of Newton-in-Makerfield: Urban District Council (Messrs. Sharpe & Co., 9, Bridge-street, Westminster, S.W.).

Pontefract Corporation Electric Lighting Order. (Amendment Order): Corporation (Messrs. Baker & Company, 54, Parliament-street, Westminster, S.W.).

Radcliffe Electric Lighting Order. The Urban District of Radcliffe: Lancashire Electric Power Company (Messrs. Clarkson & Company, 10 and 11, Lime-street, E.C.).

Rothwell and District Electric Lighting Order. The Urban District of Rothwell and the Township of Oulton with Woodlesford in the Rural District of Hunslet: Electrical Distribution of Yorkshire, Limited (Messrs. Torr & Company, 2, Millbank House, Westminster, S.W.).

Rushden and District Electric Lighting Order. The Urban District of Rushden, the Borough of Higham Ferrers, the Urban District of Irthlingborough, the Rural District of Wellingborough and a portion of the Parish of Chelveston cum Caldecott in the Rural District of Thrapston: Messrs. Francis Hugh Thornton, Brook Sampson and John Clark (Messrs. Browne & Wells, 2, St. Giles'-square, Northampton).

Sherborne Electric Lighting Order. The Urban District of Sherborne: Messrs. J. & W. Purves (Messrs. Lees & Company, Palace Chambers, Bridge-street, Westminster, S.W.).

Wath-upon-Dearne Electric Lighting Order. The Urban District of Wath-upon-Dearne: Electrical Distribution of Yorkshire, Limited (Messrs. Torr & Company, 2 Millbank House, Westminster, S.W.).

Wimborne and District Electric Lighting Order 1905 (Amendment) Order: Bournemouth and Poole Electricity Supply Company, Limited (Messrs. Lees & Company, Palace Chambers, Bridge-street, Westminster, S.W.).

Correspondence.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

ELECTRICITY AND THE MODERN MOTOR.

To the Editor of The Electrical Engineer.

Sir,—With reference to Mr. G. Basil Barham's article on "Electricity and the Modern Motor" in your last monthly supplement, I should like to point out one or two things which might have been touched upon.

First, there is the necessity of compact switching arrangements, and the combinations of the same with voltmeter, etc.

The advantage of the Lundberg "Twinob" switch for automobile work is self-evident, for this comprises two switches in the space of one. Then again, it is possible to fit a pilot lamp or other indicator to show if the tail light is "in" or "out"; this being arranged for continuous or "momentary" working. Further, it has been proposed to arrange the lamps in conjunction with a series-parallel tumbler switch, so that if the car is to be left standing for any length of time, the lamps (or groups of ditto) may be put in series and the drain on the cells diminished. This proposition alone is, in my opinion, one of considerable importance.

Lastly, the methods of "switching" the connections between the various items should be carefully worked out, with the mind's eye on the various special types of tumbler switch available and suitable for such work.

When the "items" comprise simply one or two accumulators and the lamps, something better than an ordinary arrangement of switches is possible, as has been shown above. When the equipment is a more or less complete one, comprising such items as dynamo, accumulators, lamps, pump-motor, fan-motor, heaters, hooter, cigar-lighter, etc., a great deal may depend upon a careful arrangement of connections and switches.

Yours, etc.,
W. Perren Maycock.

89, Thurlestone-road,
West Norwood, S.E.

GYRONICS AND IRONICS.

To the Editor of The Electrical Engineer.

Sir,—I have read with great interest Mr. Mellick's letter in your issue of 22nd ult. It doubtless gives a complete explanation of the wonderful outflow of energy from a dynamo when force is applied to the shaft. There are one or two questions, however, which occur to me, upon which Mr. Mellick's views would be of interest. These are:—

(1) Would the hiatus in the fabric of the magnet (assuming the gyronic capacity of the cosmos to be incapable of supplying orbital circulation without an excessive vitalisation of otherwise inaccessible matrices) become sufficiently attenuated, were an infinitesimal quantity of luminiferous ether to be enclosed in a quandary and placed carefully (no doubt gloves would have to be used) between the poles of the gyronically vitalised hoop of metal?

(2) If the explanation given is correct, how does it occasionally happen that the "stimulating to an excessive degree" of the operator directing the application of the necessary amount of force to the dynamo results not only in a mental hiatus, but in a complete orbital gyronic movement, and not infrequently in the extinction of the generated luminescence, and the repulsion, instead of the desired attraction, of the metal pieces of the neighbourhood?

These questions demand an answer before one can accept the new theory *in toto*.

Yours, etc.,
X. Y. Z.

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Books of Reference.

SOME INDISPENSABLE DESK COMPANIONS FOR THE CURRENT YEAR.

Who's Who, 1912. (A. & C. Black, 10s. net). Who's Who Year-Book, 1912-13. (Black, 1s. net).

The Writers' and Artists' Year-Book, 1912. A Directory for Writers, Artists, and Photographers. (A. & C. Black, 1s. net).

The Englishwoman's Year-Book and Directory, 1912. (A. & C. Black, 2s. 6d. net).

Hazell's Annual for 1912; a Record of the Men and Movements of the Time. (Hazell, Watson & Viney, 3s. 6d. net).

Glover's Vade Mecum. Manchester: Messrs. W. T. Glover & Company, Ltd., Trafford Park, Manchester. 12s. 6d.

The new "Who's Who" continues to live up to its high and thoroughly well-deserved reputation of being one of those few annual volumes which every business man finds absolutely indispensable. The biographies run this year to something closely approximating 24,000, and the number of pages has increased to nearly 2,400. With these large figures in the mind, it can readily be understood that not only does "everybody who is anybody" find a place in its pages, but also a good many whose appeal is much more limited. But no one will cavil at the editors on that account, while, on the other hand, the monumental labour involved will excite widespread admiration, and the accuracy which characterises its pages, and the admirable manner in which it has been brought up to date, will be cordially appreciated.

Not less valuable in its way is the "Who's Who Year-Book," with its wonderful collection of information not to be found in any other single volume—its lists of university professors, medical men, scientists, peers and peers' sons and daughters, Members of Parliament, ministers, secretaries and officials, its tables of clubs and societies with names of secretaries, rates of subscription, etc., its list of titled American ladies, Newdigate prizemen, owners of winning racehorses, prominent freemasons, managers of railways, and its great mass of other interesting and authoritative information.

Another of Messrs. Adam and Charles Black's "indispensables" is "The Writers' and Artists' Year-Book," with its clearly classified tables of publications devoted to every conceivable purpose, its lists of American, Australian, New Zealand, South African and Indian periodicals and publishers, and to its valuable guide as to the placing of manuscript. Every writer has cause for gratitude to the publishers for compiling with such care and accuracy this important information.

"The Englishwoman's Year-Book" is another volume which grows in importance and interest every year. The volume under notice is the thirtieth annual issue, and is again conspicuous for the large amount of new matter which has been included in it as well as for the completeness of the information given.

"Hazell's Annual" has been described as "a hundred blue-books boiled down into one red one." It is all that, but it is also a great deal more. It is an encyclopædia of the men and movements of the day, a mine of lively interest, and a guide to every important question of the hour. The new issue embraces some seven thousand separate references, yet each subject is dealt with in a manner which seems to leave very little more to be said. Next to the extraordinary variety and extent of its information, perhaps its most notable feature is the judicial impartiality with which it deals with debatable subjects, topics of such keen controversy as the Turco-Italian War, the National Insurance Bill, Home Rule, Electoral Reform, Welsh Disestablishment, and Labour Unrest being discussed in a manner acceptable alike to Unionists and Liberals, Anglicans and Nonconformists. As showing the "up-to-dateness" of the book, it may be mentioned that it contains summary of Sir Edward Grey's speech on the Morocco Crisis, the most important of the later amendments to the Insurance Bill, and the appointment of Mr. Anderson as Solicitor-General for Scotland. The Annual is an almanack and an encyclopædia in one, and while it is indispensable to the politician, the writer, and the preacher, it commends itself by the variety and authenticity of its information to everyone else who wishes to be well-informed.

Messrs. W. T. Glover & Company, Ltd., are issuing this year to their friends a handsome leather-bound and gilt-edged, illustrated volume of some 420 pages, dealing in a thoroughly practical manner with the manufacture and laying of cables, with colliery installations, overhead transmission, interior wiring installations and other cognate matters. The book is conveniently arranged in eight sections, of approximately 50 pages each, of which the first treats of conductors, insulated cables and E.S.C. standards; the second details the best practice in relation to trench-work, and systems of cable laying; the third with jointing, insulation of jointing, joint boxes and lead sleeves, insulating box-filling compounds, bonding and earthing; and the fourth with the maintenance and testing of earth systems and the localisation of faults. Part V. is devoted to colliery installations and deals with the choice of cables, methods of installation, and jointing, and gives the Home Office Regulations, the rules under the Coal Mines Regulation Act of 1887, and the German Rules. Part VI. is concerned with overhead lines, the selection and erection of material, the Board of Trade Regulations, etc. A model specification is given in this section together with details of the German Regulations and other valuable information. Part VII. which deals with interior wiring, embraces the selection of system and the class of wires, wood casing, conduits, insulation resistance regulations, wiring tables, fuses, etc., and gives also the Home Office rules for factories, and the I.E.E. Wiring Rules. In the last part there is gathered together a variety of very useful data and tables, Board of Trade Regulations, etc. A large number of illustrations and a copious index greatly enhance the value of this excellent volume which, despite the great mass of material it contains, can easily be carried in the pocket.

ELECTRICAL TRADES' NEW YEAR'S GIFTS.

It is a happy custom of the electrical trade at this season of the year to send to its friends its good wishes in the shape of blotters, calendars, desk companions, and other pleasant, useful and timely mementoes. The current year is no exception to the rule, and we have pleasure in here making a first acknowledgment of some of these good things.

From Messrs. Bruce Peebles & Company, Ltd., of Edinburgh, there comes a handsome desk companion in the form of a blotting pad combined with a reference book and memorandum book of generous dimensions, the pages of which consist of squared paper ruled with ten lines to the inch for engineering calculations, and thus serve a double purpose. Beneath the book, which contains abridged specifications and price lists of Messrs. Bruce Peebles' manufactures, is a memorandum slate, very useful for hurried calculations and jottings, which can be easily cleaned off when desired. The whole arrangement is of very handy and convenient size, measuring 24 inches by 12 inches, and it has the great advantage of having the reference book and diary on the right-hand side and opening backwards, thus greatly increasing its usefulness.

Messrs. Alfred Graham & Company, the well-known manufacturers of loud-speaking naval telephones, of St. Andrew's Works, Ashton Park, London, S.E., also send a very noble blotting pad combined with a diary on the same base, giving a very convenient number of pages to an opening. The blotting surface of this pad is exceptionally large, and the construction and finish are of the best.

Another desk companion of equally substantial construction and carrying with it an insurance policy for £500, is to hand from the Electrical Power Storage Company, Ltd., of 4, Great Winchester-street, London, E.C. This embraces a monthly card calendar and an excellent diary, interleaved with blotting paper which, in addition to useful details of the E.P.S. Specialities, carries with it cash account pages, index, etc.

From Messrs. Harrison, Jehring & Company, the well-known printers, of Emerald-street, W.C., comes a very useful twelve-sheet monthly Calendar, with the complete year's calendar as well as the month's on every sheet.

Messrs. Haslam & Schontheil, Ltd., send an extremely useful engagement and memo pad with a handsome and artistic cover in embossed copper.

[Further acknowledgments will appear next week].

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The Electrical Propulsion of Ships.

NOTE ON THE SCREW PROPELLER.

By Mr. H. A. Mavor.*

Summary.—An argument for referring propeller experiments to a common standard of comparison; for considering the efficiency of propellers in terms of their efficiency as pumps; and for making experiments on the propeller on the moored ship for the determination of its efficiency as a pump.

In working out proposals for the application of electricity to marine propulsion the question of propeller efficiency is a prime consideration. The use of the electric motor widens the range of choice of propeller, but it is very difficult to obtain from existing experimental data any guidance as to the effect of a proposed change in existing conditions, and still more difficult to ensure that the claims of improved economy shall be admitted as valid by the naval expert. This is the excuse for the intrusion of the electrical engineer where there has been so long a controversy.

In the case of the screw propeller there are ready to hand the means of making such a comparison. As in the case of the steam engine the comparison involves no theory as to the mode of conversion of energy, but simply treats the conversion as being accomplished without any loss due to imperfections in the apparatus. This assumes such a propeller as corresponds to Rankine's "Ideal" propeller.

The relation of the efficiency E_p of the actual propeller under trial to that of the "Ideal" or "standard propeller of comparison" is the object of the proposed investigation. (The value of E_p for the standard propeller is "Unity," for by assumption it has no loss due to imperfection.) The establishment of this relation solves the problem of "propulsive efficiency" of the propeller by separating the losses due to imperfections in the instrument from the losses essential to the transformation of energy for the purpose in question, so that one part of the investigation may be dealt with by simple dynamical calculations, leaving the remainder for definite experimental examination and comparison of results.

It is necessary for the present purpose to assume only, what will meet with general acceptance, that the propeller operates in some way upon the water so as to push it away while it pushes the ship forward. Accepting this preliminary hypothesis, Rankine's method of investigating the power which must be expended upon the water for the production of the reaction can hardly be open to question. In considering the action as applied to driving a ship, the power spent in the water is, of course, lost. The impulse imparted to the ship is the useful effect, and it is proposed to apply a new term "Impulsive Efficiency" to the ratio $\frac{x}{x+y} = E_i$ where x = the power exerted on the ship and y = the power expended on the water. In what follows, Rankine's suggestion is developed on what are believed to be novel lines, but the basis of the argument is his, except that it is proposed to apply the method for the direct measurement of quantities which he left without any indication of means for ascertaining them.

The argument may find a convenient starting-point in a consideration of the case of a propeller attached to a moored ship. Masses and weights are expressed in pounds; dimensions in feet; time in seconds.

A = The area of the cross section of the propeller disc normal to the axis.

b = The total power delivered to the propeller under trial = s.h.p.

D = The diameter of the propeller.

E_i = The impulsive efficiency of the standard propeller $= \frac{\text{t.h.p.}}{\text{net h.p.}}$

(The net h.p. is the power applied to the propeller shaft less the power lost due to imperfections in the apparatus.)

E_p = The efficiency of the propeller under trial considered as a pump $= \frac{\text{net h.p.}}{\text{shaft h.p.}}$

E = The propulsive efficiency of the actual propeller $= \frac{\text{t.h.p.}}{\text{shaft h.p.}} = E_i \times E_p$

g = The acceleration due to gravity.

M = The mass of water per second which would cross the area A in a propeller which converted the whole of the net h.p. into reaction between the water and ship, i.e., the mass of water dynamically corresponding to the thrust P, velocity V_s, and area A.

P = The total axial pressure exerted by the propeller which is measured by the "tow rope pull."

r = The revolutions at which the propeller runs.

r_1 = The revolutions at which a perfect propeller would run under the given conditions.

s = The pitch of the propeller.

S = The slip of the propeller.

V_2 = The axial component opposite to V_s of the velocities imparted to the water by the propeller.

$V_r = V_s + V_2$ = The total relative velocity between water and propeller.

Let there be a reaction between a propeller of disc area A and water, such that a total thrust P is communicated to the axis. Let the axis be restrained from forward motion. The thrust may be measured by inserting a "spring balance" in the rope which moors the vessel. There are some difficulties to be overcome in the carrying out of this experiment, but they have been overcome and need not be discussed here.

To obtain the thrust P power is applied to the propeller. As there is no forward motion of the propeller the whole of the work done is accounted for by (1) the imparting of motion to the water, and (2) by losses due to imperfections in the apparatus. As the apparatus is being dealt with as a means for producing axial thrust, only the resultant, normal to the plane of the propeller of all the various motions set up in the water is useful. All motion not contributing to this resultant is due to imperfection in the apparatus, and, therefore, falls under the second category.

Now it is a commonplace of hydrodynamics to say that if water flowing across a given area has a given pressure its velocity is known, for $v = \sqrt{2gh}$ and h is a measure of the pressure. It is more convenient to develop the argument without introducing the question of "head," and the point having been conceded, that line of discussion may be abandoned for a line more suitable.

If from direct measurement the total pressure P be known, and the area A over which it is exerted, the work done in producing the axial reaction can be calculated. Any forces which may be applied to the water to produce any other kind of motion are wasted. The area over which the pressure is exerted is limited by the diameter of the propeller. All the useful reaction must take place within that area; there all the pressure is exerted, and there all the water operated upon must pass. Where the water comes from does not matter; where it goes, or how it goes, matters less, since the thrust only is useful.

Pump Efficiency.

The work of accelerating mass M to velocity V_r is

$$\frac{PV_r}{2} = \frac{MV_r^2}{2}$$

but $M = \frac{WAV_r}{g}$ and $\frac{W}{g} = 2 \therefore M = 2AV_r$

Substituting, then

$$\frac{PV_r}{2} = \frac{2AV_r^3}{2}$$

also $V_r = \sqrt{\frac{P}{2A}} \therefore \frac{PV_r}{2} = \frac{P \times \sqrt{\frac{P}{2A}}}{2} = \sqrt{\frac{P^3}{8A}}$

but P and A are known quantities, and therefore, the work, done per second upon the water is known, and there is a means of measuring the efficiency of the propeller as a

* Abstract of a Paper read before the Institution of Engineers and Shipbuilders in Scotland.

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pump by the ratio $\frac{\sqrt{\frac{P^3}{8A}}}{b} = E_p$ (1). Now let the relative velocity V_r between propeller and water remain the same, but let the propeller, still acting simply as a pump, move forward through the water on which it operates so that the acceleration of mass M is $= V_2$ and the forward motion is $= V_s$:—then $V_2 + V_s = V_r$.

P is the total pressure normal to the surface A.

PV_s is the work of propulsion.

Then $\frac{PV_2}{2} = \frac{MV_2^2}{2}$ = rate of doing work on mass M = $2AV_r$ as before,

$$\therefore \frac{PV_2}{2} = \frac{2AV_rV_2^2}{2} \text{ or } V_rV_2 = \frac{P}{2A} \quad .. \quad .. \quad (2)$$

also $$(V_2 + V_s)V_2 = V_2^2 + V_2V_s = \frac{P}{2A}$$

$$\therefore V_2 = \sqrt{\frac{P}{2A} + \left(\frac{V_s}{2}\right)^2} - \frac{V_s}{2} \quad .. \quad (3)$$

The efficiency of the propeller as a pump may again be measured if the values b, P, A and V_s be known.

It is $$E_p = \frac{P\left(V_s + \frac{V_2}{2}\right)}{b} = \frac{x+y}{x+y+z} \quad .. \quad .. \quad (4)$$

V_2 is calculated from (3).

THE "PROPULSIVE EFFICIENCY."

$$E = E_i \times E_p = \frac{x}{x+y+z}$$

If the value of P has not been ascertained by tank trials or otherwise, it may be experimentally determined by measurement of the shaft horse power b, and by experiments on the moored ship to determine the friction and eddy losses under conditions which should be made to approximate as closely as possible to the running conditions in respect of rate of revolution and of total pressure. Having by these experiments determined E_p from (1) and calculated $x + y = b\,E_p$ the "impulsive efficiency" E_i may be determined as follows:—

THE "IMPULSIVE EFFICIENCY."

$$\frac{x}{x+y} = E_i = \frac{PV_s}{P\left(V_s + \frac{V_2}{2}\right)} = \frac{1}{1 + \frac{V_2}{2V_s}} \quad .. \quad .. \quad (5)$$

Reverting to (2) $V_rV_2 = \frac{P}{2A}$

$$\therefore (V_2^2 + V_2V_s)2A = P \quad .. \quad (6)$$

Let $P\left(V_s + \frac{V_2}{2}\right) = x + y$ and $\frac{x+y}{V_s + \frac{V_2}{2}} = P$

then $$\left(V_s + \frac{V_2}{2}\right)\left(V_2^2 + V_2V_s\right)2A = x + y \quad .. \quad (7)$$

There are several methods of solution for this equation. One is to get a particular solution for each case by plotting $\frac{x+y}{2A}$ to arbitrary values of V_2, calculating a few points, and plotting a curve which will show the value of V_2 corresponding to the prescribed values $x + y$ and V_s.

If P and V_s be known, it is evident that the area required for any predetermined Impulsive Efficiency E_i can be immediately ascertained from (2) for

$$\frac{PV_s}{PV_s + \frac{PV_2}{2}} = E_i = \frac{1}{1 + \frac{V_2}{2V_s}} \quad .. \quad \text{see (5)}$$

and V_2 is known from the predetermined value of E_i. Then from (2) $A = \frac{P}{2V_rV_2}$

Conversely, if A be determined by considerations of draught beam, etc., the impulsive efficiency is known in terms of V_s, and the only remaining variable is z, the loss due to imperfections in the apparatus. The separation of this loss from the essential loss determined by the impulsive efficiency associates the results of experiment directly with the particular apparatus in question, and permits of a real comparison of "E_p," the pump efficiencies of various propellers, in respect of their individual properties uncomplicated by the dynamical conditions under which they operate. (The pump efficiency of the standard propeller being taken always as $E_p = 1$.)

USE OF RECORDS.

There are here two uncertain elements if the choice of A be unlimited; they are E_i and z. If A be fixed there is only one uncertain element, and for the determination of this last it is here proposed that experimental records should be so treated as to form a means of estimating the value of z.

Trial trip results where P, V_s and b, ascertained or known in part from previous experiments, are directly available for the determination of this quality, but tank experiments are not always available, and it is fortunate that there is a method of approximating to the value of E_p by experiments with the moored ship.

(I) $$E_p = \frac{\sqrt{\frac{P^3}{8A}}}{b}$$

P in this case is the total pull on the rope which moors the ship, measured by a spring balance. If a torsion meter is not available a close approximation is obtained by assuming the engine efficiency $= \frac{b}{\text{i.h.p.}}$

An examination of a number of trials leads to the conclusion that the efficiencies of propellers are of the same order as those of the centrifugal pumps of commerce, namely, 70 to 80%, depending largely on the quality of the blade surface and, to a less extent, on the developed area of the blade surface, number of blades, etc. It is easy on the lines indicated to make comparisons between actual propellers of full size showing the result of any modifications which may be made, clear of any questions depending on speed, form of ship, or other matters with which the propeller has nothing to do. It must be stipulated, of course, that the moored trial should be in deep open water.

It is well known to designers of marine drives that a good normal efficiency of propeller is associated with a slip of 20%. Examining this on the proposed basis

$$1 - \frac{V_s}{V_r} = 0{\cdot}2 \text{ gives}$$

$$\frac{V_s}{V_2 + V_s} = 0{\cdot}8 \text{ and } \left(\frac{V_s}{0{\cdot}8} - V_s\right) = V_2$$

$$V_2 = 0{\cdot}25\,V_s$$

and from (6)

$$E_i = \frac{1}{1 + \frac{V_2}{2V_s}} = \frac{1}{1 + \frac{0{\cdot}25}{2}} = {\cdot}8$$

which is very close to 90%, thus shown to be the ordinary practical limit of impulsive efficiency. This efficiency is always attainable where there is no limitation of propeller diameter. In such a case the propulsive efficiency

$$E = E_i \times E_p = {\cdot}8 \times 8 = {\cdot}71.$$

A condition which frequently limits the impulsive efficiency is that if the propeller be made unduly large to get a high efficiency the pump efficiency E_p is impaired by the load being too small for the size of the pump, a condition well known to be unfavourable to efficiency. A pump efficiency of ·8 is higher than is usually attained with iron or steel propellers, ·7 is probably nearer the value for a safe estimate on the ordinary propellers of cargo boats.

WAKE-FACTOR.

Up to this point the identity of V_s, the speed of the ship with the actual speed of the propeller through the water in which it operates has been assumed. It is well known that this identity is not realised in practice, and various methods of correction are in common use for eliminating the error involved in this assumption. These methods are just as applicable in this manner of investigation as in any other, and if the subsequent argument fails to appeal to the designer he may stop here and correct the trial trip speed by the use of his wake-factor, making V_s what he considers the true speed of the propeller through the water.

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It is suggested that the voluminous records of tank and other trials of experimental propellers, studied on the lines here indicated, will lead to a better understanding of this very difficult branch of the subject. To go through the details of a study which the writer has carried out would be nearly as tedious as the study itself, but a few impressions gathered from these records may be of some interest.

It appears that in addition to the "effective" thrust of the propeller there is a thrust expended in overcoming the resistance offered by the water to the forward motion of the propeller blades, boss and shaft. This, which may be termed resistance internal to the system, may lead to very complicated modifications of the dynamical condition. Among these modifications there are signs of a forward motion of the water pushed in front of the propeller and giving the effect of a "wake;" this wake probably has a rotary motion round the axis as well as parallel to the axis, so that the velocity of V_s of the propeller through the water and also the residual velocity V_2 of the water are doubtless both materially modified. This implies also a material modification of the interchange and distribution of energy in the system, but these modifications are not susceptible of direct investigation. They may be examined by their secondary effects, for example, on the rate of revolution of the propeller. Some of the effects are favourable and some are unfavourable to efficiency, but on the whole they may be treated as associated with imperfections in the instrument.

Where the slip is about ·2, it will be found that rs is very closely approximate to r_1s. Where the conditions are less normal the relation between these quantities can alone be determined by special experiments which will have little bearing on the properties of any other propeller than that to which they are applied, but these properties can be directly compared in respect of performance with the standard propeller, and through it with any other actual instrument.

The effect of the ship's wake can be examined by comparison of the trial trip results with the tank trials of ship and propeller, and also of the moored trials at progressive revolutions. The writer has made many comparisons by means of published records of trials, and the method here proposed seems to clear off in many cases apparent anomalies in the results. The expedient is simple. It is the use of rs and r_1s, instead of the slip which has the value

$$S = 1 - \frac{V_s}{r_1 s} \text{ or } S_a = 1 - \frac{V_s}{rs}$$

where S = the slip of the standard propeller.
and S_a = the slip of the actual propeller.

The power delivered to the screw propeller by the shaft is disposed of in three ways. 1st. In overcoming the resistance to motion in an axial direction. The value of this power is $PV_s = x$. 2nd. In performing work upon a body of water to produce the necessary reaction to give the forward thrust in the axial direction. The value of this power is $\frac{PV_2}{2} = y$, and (3) and (7) show how to ascertain the value of V_2. 3rd. In power spent upon friction imparting unnecessary motion to the water and in other undefined losses. This third factor is called z, so that the whole power delivered to the shaft is $b = x + y + z$. The value of z can only be accurately determined by direct experiment on the individual propeller in question, but its properties can be examined without the necessity for running special speed trials. This value z is affected materially when wake effect is present, and it is suggested that the association of the results of experiment when the propeller is and is not working in a wake can be more effectively compared when the first two ascertainable elements x and y have been eliminated.

The practical effect of the wake is less disturbing than might be anticipated. It operates generally in the direction of an apparent improvement in the value of "E," the propulsive efficiency. This improvement cannot be due to improvement in pump efficiency E_p and, therefore, it should be credited entirely to E. A comparison between the expected value and the recorded value of E is, therefore, a valid means of estimating the wake, whether it be produced by the propeller itself or by the ship.

So much for the practical interpretation of trial results. The problem which faced the writer is—What is in general and in particular the effect upon the efficiency of change of revolutions? Now, this question can be answered.

Given d, s, V_s, b.

Assume E_p = ·8, or any other figure which experience may dictate.

$x + y = E_p b$.

Solve (7) for V_2, and from (5) calculate E.

Then $(x + y)\,E = PV_s$ and $P = \frac{PV_s}{V_s}$

Now assume that restrictions on revolutions and diameter are removed, and aim at impulsive efficiency ·9 = E.

At these efficiencies r_1 is approximately equal to r.

Then $\frac{V^2}{2V_s} = \frac{1}{E} - 1 = ·1$ and $V_2 = ·2\,V_s$

also from (2) $A = \frac{P}{2(V_s + V_2)V_2}$

$$r_1 = \frac{V_s + V_2}{s} = \frac{1{\cdot}2\,V_s}{s}$$

Experience alone can guide the naval architect in the matter of pump efficiency. A number of records of actual trials have been carefully examined, and the efficiency suggested, namely, E_p = ·8 is the result for modern bronze propellers. Further, it appears that the friction and other losses = z are in actual propellers on ships of the order $\frac{D^5 r^3}{10}$ and this may be used as a check on the approximation.

The writer thinks that the shipbuilder who builds up his records on the basis of pump efficiency of his propellers, corrected by due observations on the revolutions as a measure of the wake, will make his records of real scientific value to himself and his friends, and a much more satisfactory standard of reference than experiments on the propulsive efficiency of small propellers and insignificant powers.

Taylor's Experiments.

Dealing with the results of Taylor's experiments on propellers as recorded in his paper to the American Institution of Naval Architects, the author observes that ·4 is a pitch ratio which is very rarely used, but for a high speed propeller of large horse power working under conditions which preclude the attainment of high efficiency even ·4 pitch ratio might have its place. The same remarks apply with less force to ·6 pitch ratio. Coming to deal with the more normal pitch ratios of ·8, 1 and 1·2, the efficiencies shown by these propellers lie between about 75% and 83% over the whole range of the experiments, and it is clear that there is a critical rate of revolution and power developed below which the efficiency falls off very rapidly, and that there is a working range through which the "pump efficiency" remains constant, or nearly so, falling away as the load is increased, but the point of real maximum efficiency of a propeller, considered from the point of view of its own individual properties, never can occupy the same place as the point of maximum efficiency which is derived from a combination of its own properties and those of the ship which it drives.

In an appendix Mr. Mavor gave the results of trial trips of 10 ships examined.

London Electrical Engineers.—Officer commanding, Lieut.-Col. H. M. Leaf. Orders for week ending January 13:—Monday, January 8.—"A" Company: Technical work, musketry instruction (Standard tests), 7 to 10 p.m. Tuesday, January 9.—"B" Company: Technical work, musketry instruction (Standard tests), 7 to 10 p.m. Thursday, January 11.—"C" Company: Technical work, musketry instruction (Standard tests), 7 to 10 p.m. Friday, January 12.—"D" Company: Technical work, musketry instruction (Standard tests), 7 to 10 p.m. Saturday, January 13.—Headquarters will be opened for Regimental business from 10 a.m. to 12 noon.—(Signed) J. H. S. Phillips, Major, for Officer Commanding London Electrical Engineers.

We are asked to say that thanks are tendered to the persons who applied for the post of shift engineer at Stockton-on-Tees, and are now informed that this appointment has been filled.

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Electrical Progress at Home and Abroad.

UNITED KINGDOM.

Lighting, Power, Telegraph, Telephone, and General Business Notes.

BARKING.—Mr. T. C. Ekin has concluded the Local Government Board inquiry into the application of the Urban Council for sanction to a loan of £11,000 in connection with the electricity undertaking. Strong opposition was offered by the Barking Traders' Association, by the local manager of the Gas, Light and Coke Company, and by the Ratepayers' Association.

BELFAST.—The Electricity Committee of the Corporation has decided upon the following new scale of charges, which will come into operation forthwith, namely: Flat rate per unit, 3½d.; on maximam demand system an initial charge of 5d. for the equivalent of 162 hours' consumption at the consumer's maximum demand per half-year (equal one hour per day), and a subsequent charge of 1½d. per unit for all in excess of this quantity; private house lighting, a flat rate of 3d. per unit; for power and heating and purposes other than lighting, in addition to the existing rates, consumers have the option of being charged at the following rate, which will be found advantageous when the maximum demand is used for a period of not less than nine hours per day; on the maximum demand system, an initial charge of 2d. per unit for the equivalent of 364 hours' consumption at the consumer's maximum demand per half-year (equal to two hours per day), and a subsequent charge of ¾d. per unit for all in excess of this quantity.

BLACKPOOL.—The promenades are to be electrically lighted by means of 250 arc lamps each of 2,000 c.p. and by 500 intermediate incandescent lamps of lower power.

DUNDEE.—Further attempts to secure telephonic connection between this town and Paris have proved a complete failure. The "Dundee Advertiser" made the experiment after telegraphing to Mr. Hedeman, the editor of "Le Matin," that the trunk call would be made at a certain hour. Paris was duly linked up, but beyond a single faint "hallo" nothing could be heard over the wires. Later on Paris called Dundee, but with wholly negative results, not a syllable being audible.

GLASGOW.—At a mass meeting of National Telephone Company employees on December 28 strong protests were made against the conditions of service offered by the Government. Mr. Hale, who presided, said that the points which the telephone operators insisted on were:—No individual member of the staff to suffer hardship as a consequence of the transfer of the business to the State; to secure that years of service with the National Company count as years of service with the State; to secure the establishment under the Post Office of all members who have permanent positions with the National Company; to obtain the removal of all examinations, medical or educational; determined opposition to examinations of any kind as essential prior to promotion; to secure continuity of employment to the constructional staff; to see that no member of the staff should suffer loss or hardship at any date subsequent to transfer. He commented on the fact that while the Government could pay members of Parliament they apparently had no money to remunerate properly the telephone staff. They had been "diddled" too long, and as under the new conditions they were likely to suffer considerable loss through a reduced minimum, he held that they should make a spirited protest. It was then resolved, with three dissentients, that "in the opinion of this meeting of Glasgow telephone employees, the classification as presented is ambiguous and indefinite, and that in consequence this meeting does not think that any employee should sign any Post Office service form until satisfactory arrangements have been made for every member of the staff."

GODALMING.—At a meeting of the Council consideration was given to the report of the Highways and Lighting Committee, who stated that schemes had been submitted by the Godalming Gas Company and the Urban Electric Supply Company for street lighting for five years from July 1 next. The cost of the lighting at present was £854 per year, all lamps being extinguished at midnight. For lighting during the same hours, but with improved candle-power lamps, the Gas Company made an offer of £725 10s., whilst the Electric Light Company's price was £758. For lighting all the lamps up to midnight, and every alternate lamp up to sunrise all the year round, the Gas Company offered to provide 10 lamps of 600 c.p. each in the main streets and 250 lamps of 70 c.p. each in the other streets and roads at £993 per year. The Electric Light Company offered 10 lamps of 800 c.p. each in main streets, 115 lamps of 100 c.p. each and 132 lamps of 50 c.p. each in other streets and roads, the tender being £850 per year. The committee recommended the acceptance of the Electric Light Company's tender, and said the company was willing to give the Council the option of determining the contract at the end of two years on payment of £90, or in five years on payment of £30, these sums being required owing to the new capital expenditure which the company would have to undertake in altering the present system. The report was adopted.

GREENOCK.—The headquarters at Fort Matilda of the Electrical Engineers are to be extended by the erection of a new armoury store-room and other buildings in order to provide additional accommodation for the men of the Glasgow and Greenock Companies, who carry out their annual training at the Fort. The work is to be begun this week.

LEEDS.—Mr. H. R. Hooper opened a Local Government Board inquiry into the application of the Corporation for sanction to a loan of £60,000 for extensions to mains and improvement of plant at the distributing stations. The demand for power, apart from the increase in lighting, has grown so rapidly that the capacity of the feeder mains has several times had to be increased and the Corporation now supplies power for driving the works of some of the largest forges and locomotive makers in the city, as well as clothing, boot, and other factories. From their power and lighting departments the Corporation now derive annually a revenue of £104,000, and last year a profit of £10,000 was earned in relief of rates. Within the last 10 years the expenditure on the distribution side of the work has reached £75,000 in a year. The comparatively small extensions now proposed to the mains are likely to prove of a most profitable kind, because they will help to utilise to a fuller extent the much larger expenditure that has been incurred in the past in laying down trunk mains or feeders. It is estimated that this year the department will be able to earn a profit of £12,000.

LEICESTER.—In a report to the Council, the Tramways and Electricity Committee state that representations have been made to them by consumers of current for power purposes, that the existing system of a basic charge of 10s. per quarter per horse-power and ¾d. per unit subject to discounts, is complicated and inconvenient. Subject to the approval of the Council, the committee have adopted a flat rate scale of charges, which they recommend should be put into operation in substitution for the present charges, but with an option to customers under current agreements, who prefer to do so, to continue to be charged on the present terms. The committee feel that there is likely to be a considerable demand in the near future for the supply of electric current for cooking and heating purposes providing such supply can be given at a fairly low rate, and they have therefore decided, subject to the approval of the Council, to reduce the charge for such purposes to 1d. per unit.

LIVERPOOL.—Electric supply matters are in future to be considered monthly by the Tramways and Electric Power and Lighting Committee. The committee will meet twice a month, but at one meeting will consider only tramway matters and at the other only lighting and power questions.

MAIDSTONE.—The 10th anniversary of the opening of the Electricity Works was, by invitation of Alderman Vaughan, Chairman of the Electricity Committee, celebrated by a dinner at the Queen's Head Hotel. In proposing success to the undertaking, Alderman Vaughan, after expressing his

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pleasure that they still had with them their able electrical engineer, Mr. E. E. Hoadley, said that in December, 1901, when the works were started, they had 73 consumers, and during the first 15 months ending March, 1903, they sold 303,688 units, of which number only 28,077 were for power supply. The whole of their revenue for this period was £5,031. In the year ending March 31, 1911, they had 834 consumers, actually taking current, and they sold 1,654,230 units, of which number 659,476 were for industrial power purposes, exclusive of traction supply. One of the most pleasing parts of the reports of this undertaking was that there was more than 1,600 h.p. of motors connected from the mains at the present time. He added that 150 of this 1,600 h.p. was used for pumping the sewage at Allington. This left 1,450 h.p. of motors, which was now actually used in the town for manufacturing purposes, which spoke well for a town of the size of Maidstone. The total revenue produced for the year ending March 31 last was £13,641. Thus, in 10 years, they had increased their output nearly seven times, the units sold had multiplied themselves over 23 times, whilst their total revenue had increased nearly 3½ times, and while the units sold had gone up nearly seven times, their coal bill had only increased 2¼ times. The units sold for private lighting in March, 1903, were 162,350, but in March, 1911, they amounted to 318,034. The units for power supplied in 1903 were 28,077, and in 1911, 659,476. The tramways now took about 400,000 units yearly. The capital taken up for carrying on these works amounted to £80,643, and up to March 31, 1911, they had repaid of this amount £21,148, which, if the undertaking belonged to a company, would practically be profit, and, in addition, they had paid interest on the money amounting to £20,888. Thus £42,000 had been repaid in the way of interest and for repayment of capital, and at the same time they had been able, by good management, to supply electricity for lighting at a price they could not find in almost any other town of the size of Maidstone, and had also been able to supply current at 1d. per unit for trade purposes. In their first year it cost them 2·4d. to generate a unit of electricity. To-day the cost was nine-tenths of a penny. In conclusion, he mentioned the interesting fact that the local Gas Company and the electricity undertaking were the best of friends.

OLDHAM.—The Corporation has decided to apply to the Local Government Board for additional borrowing powers for extensions to the electricity undertaking. Estimates prepared by Mr. Newington, Borough Electrical Engineer, indicated that £6,424 was required for turbine, condensers, and water pipes and foundations for same (£5,900 being for turbine alone); switchboard extension and cables would require £544, superheaters, £1,571, mechanical stokers, £2,028, three years' mains expenditure £8,000, three years' service expenditure £1,000, making a total of £19,567, which amount it was decided to ask for permission to borrow. The total number of lamps, motors, etc., connected to date is equal to 197,574 lamps of 8 c.p.

PUTNEY.—Christmas and New Year weeks have been marked by special electrical illuminations, some hundreds of coloured lamps having been festooned across the principal streets. The arrangements were carried out by the County of London Electric Supply Company, Ltd.

RATHMINES.—The Council's Electrical Engineer, Mr. Filditch, and Captain Smith, of the Fire Brigade, have made satisfactory tests of a new electrically driven "first aid" fire engine built to the order of the Council by Messrs. H. Simonis & Company, of Walthamstow. It is of 30 h.p., and will seat 12 firemen. It carries about 2,000 ft. of hose and the usual accessories, and is fitted at the rear with two first-aid engines, which will hold about 25 gallons of water. The discharge is by carbonic acid gas, having a working pressure of 120 lbs. to the sq. in. The machine can go 30 miles in one charge of the battery, and can travel at the rate of 25 miles an hour. The electrical charge can be made from the township's electrical works, and thus there is no cost to the ratepayers when the machine is lying idle.

SKELMORLIE.—The electric lighting scheme was inaugurated on Thursday by Lady Montgomerie, and the event was celebrated by a dinner at the Hydro, at which Mr. John Pattison presided. Mr. Hale Brown gave the toast of "Success to the Skelmorlie Electric Lighting Company," and Mr. Munro, consulting engineer to the scheme, in replying, stated that the little plant installed some years ago by Dr. Philp to light the Hydropathic, and extended afterwards by Mr. H. V. Farnham, the electrical engineer, to give electricity to several neighbouring houses, is now owned by a private limited company, who, after obtaining a Board of Trade order, have erected and equipped a power station with the most modern plant for the day and night service of the whole district. The gas engines—two of 100 h.p. each and one of 35 h.p.—are supplied from three suction gas producers—one Crossley, one National, and one of the new and wonderfully economical producers designed by Mr. Farnham. The dynamos are by the Electric Construction Company (Limited), the storage battery by the Tudor Company (Limited), the switch board by Kelvin & James White (Limited), lamp posts by Edison & Swan Company (Limited), and the public and private lighting cables by Callender's Cable Company (Limited). The running plant alone can supply 5,500 lamps, each of 25 c.p.

ST. PANCRAS.—Sanction has been received from the London County Council for the borrowing of £9,964 for electricity purposes and a further sum of £350 is to be made a revenue charge.

STALYBRIDGE.—At a meeting of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, it was decided that application be made to the Local Government Board for their sanction to the borrowing of £16,850 for additional plant at the generating station at Stalybridge, £10,000 being the amount estimated to be required for mains during the next three years, and £5,000 for the purchase of transformers and switchgear during the next three years. The extensions to the generating plant include the purchasing of new turbines, pipework, boilers, mechanical stokers, etc.

TYNESIDE NOTES.

Dr. Thornton on Sparking from Armoured Cables—Meeting of the Mining Electrical Engineers—Resignation of Mr. Clothier.

At the December meeting of the Newcastle branch of the Association of Mining Electrical Engineers an able paper was read by Professor W. M. Thornton on "Sparking from Armoured Cables," in which he described the results of an experiment recently carried out with the co-operation of the Newcastle Electric Supply Company. In his prefatory observations, Professor Thornton said that when the current in an electric circuit having the capacity of inductance was suddenly interrupted, the energy momentarily stored under electric stress in the insulating medium, or in the magnetic field produced by the current, was dissipated in the flash at break, or in oscillations set up before the circuit was fully broken.

These oscillations, said Dr. Thornton, occurred in both continuous and alternating current systems, and were set up in the rapidly falling arc. Their frequency was many thousands per second, but unless the capacity of the system was very small in comparison with the usual capacity of electric cables, their amplitude was by no means great, though at the same time there was undoubtedly the possibility that when a circuit containing a sheathed or armoured cable was interrupted, the oscillations on the inner conductor might, by electrostatic induction through the circulation, cause similar movements on the sheath of such magnitude that if the latter were inefficiently sheathed, sparks might pass to any neighbouring conductor.

It was considerations of that kind, he said, that at the time of the Hulton Colliery explosion led to a suggestion that gas might be ignited by sparks from cable armouring induced at the moment of breaking the current circuit. It was demonstrated that gas could be ignited by the sparks between two isolated conductors in a region through which electro-magnetic waves were passing, but it remained to be seen whether the oscillations on a cable sheath had sufficient energy to give a similar effect. In the case of three-phase cables no oscillations could be expected on the sheath, provided that the three flashes of break were equal, but that was a condition never met with in practice and by the nature of the case was virtually impossible. They could never get, theoretically, an equal flash from all three

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phases; they could never break all three phases with a single current in each. The oscillations, however, could not be as marked as those in a cable with a single voltage to earth, and in the experiment already mentioned the latter was adopted as the most vigorous test that could be applied.

Referring in detail to this experiment, he said that a length of 200 yards of lead-covered, paper-insulated cable, $\frac{5}{8}$ in. diameter over the sheath, containing three cores arranged for three-phase transmission, was kindly lent for the purpose of the experiment by the Newcastle Electric Supply Company. It was laid out, anti-inductively, upon earthenware insulators, on the dry and polished floor of the large hall of the college, forming several complete turns with the coils separated about a foot or more from one another. The ends were led into the electrical engineering laboratory and connected through a single-pole switch and a suitable open fuse arrangement, so that any desired suitable current could be broken either quickly or slowly. The insulated sheath was first connected so that its two ends were joined through a needle-point spark-gap, beneath which a Bunsen burner was placed. A current of 6 amperes at 280 direct volts was then broken slowly, the flare lasting several seconds, with the gas turned on in readiness to ignite if a spark passed between the ends of the sheath. None was observed, however closely together the points were set. A vacuum tube containing Neon gas was then placed across between various points on the sheath with no visible effect. The current was then changed to 50 amperes at 100 volts without any apparent external oscillations. As a final test the cable was short-circuited through a light fuse across 480 volts, the sheath being carefully insulated. The current reached about 250 amperes, the fuse clearing instantly with the usual flare favourable to the production of oscillations. To prolong the time a little, a horn arrester was connected in parallel with the fuse. As before, no trace of spark from the sheath could be seen. It could not be doubted that oscillations did occur on the sheath, but the experiments proved that under conditions electrically resembling those of practice they were so feeble that there was no danger to be anticipated from them in coalmines.

Dr. Thornton regarded that result as very satisfactory from the point of view of the mining electrical engineer, but there were cases, he said, where sparking had been observed from armouring. For that there were several possible explanations, all of which assumed that the earthing armouring was not perfect. If that were so, a leakage through the insulation, however feeble, would, of course account for it. In the case of direct-current cables, isolated after being under pressure for some hours, a residual charge in the insulation leaked out, and, if it could not escape by way of surface conduction, remained at a sometimes high potential, inducing an equal charge on the sheath. The outer charge tried to spread itself over as large an area as possible, and a spark might pass to earth, or to any conductor brought close to the sheath. That would apply equally well to a single-phase system in which the pressure had been cut off at a crest value, or, in a much less degree, to a three-phase system with unbalanced voltage interrupted at a high value on one conductor. If it were reported that sparks could be always obtained from the armouring, the plant should be examined for any high currents and for bad earthing. There could be no spark to earth from a perfectly earthed sheath or armouring, though to obtain these conditions it might be necessary to use a pilot cable, and to connect it to the armouring at several points. The possibility of sparking as a result of violent oscillations on an inner conductor was shown by the present experiment to be so remote that it might be dismissed as a cause of anxiety in coalmining practice.

Among other papers read at the meeting was that by Mr. Kilburn Scott on "Electricity in Connection with Explosives," an abstract of which has already appeared in the ELECTRICAL ENGINEER.

A regrettable event of the meeting was the resignation by Mr. H. W. Clothier of the office of honorary secretary, a course which he had been impelled to take owing to the pressure of other work. A cordial vote of thanks was accorded to Mr. Clothier, who, in reply, said Mr. Leslie Robson had practically been doing the bulk of the secretarial work for some time past, and the committee had arranged that he should continue it.

AMERICAN NOTES.

Variable Speed Alternating Current Motors—A Suggestion towards Economy—Electrolysis Troubles and their Remedy—Operating an Electric Train.

At a meeting of the American Institute of Electrical Engineers, Mr. G. A. Maier, in the course of a paper on variable speed alternating current motors, put forward the thesis that an adjustable speed alternating current motor can be even inferior to the direct current motor and at the same time effectively supplant it. In developing his postulate, Mr. Maier referred to the Hunt scheme for obtaining two or three set speeds in a single induction motor by means of internal concatenation. In one of the Hunt motors the stator core is provided with an eight-hole primary winding equipped with taps brought out in such places that the winding can act simultaneously as the short-circuited secondary to a four-pole field produced on the rotor secondary. The secondary winding is arranged so that it may be either directly short-circuited on itself or connected to produce the effect of a four-pole winding operating in an eight-pole field. The motor can operate either as an eight-pole squirrel-cage induction motor or in concatenation with a speed corresponding to 12 poles, and Mr. Maier contended that it is possible to design a cheaper two-speed motor of the Hunt type than one of the ordinary collector-ring type with two primary and two secondary windings. A considerable demand exists at the present time for an adjustable-speed, alternating-current motor, even if it be a little inferior in characteristics to a direct-current motor, in order to overcome the necessity of installing direct-current apparatus rather than alternating-current apparatus merely because a few of the many motors must be of the adjustable-speed type. The author outlined the circuit connections and operating characteristics of the adjustable-speed, single-phase motor of the compensated-repulsion type. As reduced to the two-pole model this motor is provided with four brushes. Two of these brushes act as the transformers secondary to the stationary primary which receives all of the useful power of the machine; the other two brushes act as part of an exciting circuit. When both sets of brushes are short-circuited on themselves the motor operates at practically synchronous speed as though it were a squirrel-cage-type, single-phase induction motor. By introducing into the exciting circuit an E.M.F. in time-phase with the supply E.M.F. the wattless current in the primary circuit can be adjusted to any required value, either positive or negative, according to the relative polarity of the introduced E.M.F. By introducing into the transformer secondary brush circuit an E.M.F. in time-phase with the supply E.M.F. the speed can be adjusted to any required value either above or below synchronism.

Minimising Commutation Troubles.

Dealing editorially with Mr. Maier's suggestions, the "Electrical World" observes that if one were permitted to ignore the requirements of commutation, it could be stated with some confidence that the adjustable-speed alternating-current type of motor may be built and operated more satisfactorily than a motor of the direct-current type, and this statement would be based on the fact that the stationary transformer affords a convenient and economical device for voltage variation which has no counterpart in direct-current equipment. The field-magnetism and armature-voltage variation methods of speed adjustment can be applied to alternating-current commutator motors with results which are identical with those obtained with direct-current motors. The correct time-phase relation between the armature current and the field magnetism can be absolutely insured by impressing across the field coils an E.M.F. 90 time-degrees displaced from the E.M.F. impressed across the armature; that is, by connecting the field coils across one phase, and the armature across another phase, of a two-phase system. Such a motor can be accelerated from rest with the maximum value of torque per armature ampere by the use of a non-inductive rheostat, such as is employed with direct-current motors, while speed adjustment can be obtained by varying the voltage across either the field coils or the armature. A disadvantage of this type of motor

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resides in the transformer E.M.F. produced in the coil short-circuited by the brush, which renders the commutation unsatisfactory in the simplest form of the motor. Commutation difficulties can be minimised by introducing a counteracting E.M.F., or reducing the current produced in the short-circuited coil by internal or external resistance leads. Another method of minimising the commutation troubles consists in introducing the electrical energy into the armature inductively rather than conductively by utilising the so-called repulsion principle. In the simple form of the repulsion machine, with the energy brushes short-circuited, the commutation difficulties disappear at synchronous speed, and at all speeds they are less than in the above-mentioned adjustable-speed motor, even when the change in speed is produced by introducing an E.M.F. in the energy circuit. Commutation troubles have not yet been completely eliminated, but it is not too much to expect a rapid improvement along this line as experience is gained with motors now being developed and as inventors and investigators realise more and more the importance of producing an alternating-current motor suitable for competing favourably with the adjustable-speed direct-current machine.

Electrolysis Troubles.

An official report by Mr. Ericson, city engineer of Chicago, goes to show that if the earlier statements as to the damage caused by electrolysis from electric railway return currents were exaggerated, the trouble is, nevertheless, a sufficiently serious one, and will necessitate a very heavy outlay on the part of the railway companies in the way of remedial measures. It has been found that the return conductors are defective and insufficient to keep return current from damaging and destroying underground metallic pipes, etc. Both water-mains and gas-mains were found in cases to be much pitied. On one 36-in. water-main the pits were ¼ in. or more deep. In one case it was found that 30 amp. was flowing in a 24-in. water-main, and in another case 143 amp. in a 36-in. water-main. It was found that the return conductors of the elevated railways do not have sufficient capacity at present to keep the electric current from straying, and it is recommended that large cables should be run from one end of the elevated structure to the other, tapping all track rails every 300 ft. The report states that while there is no practical way of determining how much water leakage is due to damage caused by electrolysis there is probably a considerable loss from this cause. The lead-sheathed cables of the city police and fire alarm system, telephone, lighting and power companies are being considerably damaged, and that the telephone and electric light companies find it necessary to keep a force of men in the field working continuously in order to protect their underground investment from stray-current damage. Stray currents were found to be carried by pipe in structural-steel buildings, and other metallic structures, cable sheaths, bridges and structural steel buildings are being damaged.

Remedial Measures.

Various remedial measures are suggested, and some of these are to be adopted without delay. It is recommended that the present ordinance limiting the difference of potential due to stray currents to 25 volts be changed so as to reduce this limit to 12 volts, and that the railroad companies be required to equip their return systems with insulated metallic-wire circuits and voltmeters, whereby at any time the difference of potential can be determined between the negative busbars in each station and the extreme limit of the return circuit in the corresponding feeding district. The companies are also, it is urged, to be required to install a system equal to or better than a pipe and cable sheath drainage system, consisting of insulated copper wires, pipe straps, ammeters, etc., whereby the maximum amperes flowing in sub-surface pipes, etc., shall be limited to 10 per cent. of the total output of the station. When the stray currents are reduced to an amount corresponding to 12 volts of maximum drop it is stated that pipes, lead sheath and other sub-surface metallic work can be protected by a properly installed pipe and cable sheath return "drainage" system. It is also recommended that the railway companies be required to make one or more of the following improvements: (a) reconstruct all defective track work and install additional return feeders; (b) install a negative busbar system; (c) install a return current "drainage" system; (d) reduce the size of power plant in sub-station feeding districts; (e) insulate the railway return circuit. Another recommendation is the installation of a number of large insulated cables between different points of pipe lines and the feeding station negative busbars in each district. All electric railway river crossings and bridges should be so equipped with bonds, contacts and additional feeder cables, in order that no appreciable leakage shall result when cars are operated over the bridges or when the bridges are open. All special work, dead-end lines, steam-track crossings, surface and elevated line crossings, etc., should have jumper cables of equal conductivity to the rails, and additional return cables should be installed and tapped at regular intervals into the cross bonds and rails.

Operating an Electric Train.

Details are published in the New York "Electrical World" of some remarkable claims in a patent, or series of patents, which have recently been issued by Mr. Ward Leonard. One claim is on a method of operating an electrically propelled train comprising one or more vehicles, consisting in generating high-tension, single-phase energy, conducting it upon the train, and there transforming it into energy of sufficiently low tension to be regularly commutated, dividing the energy and supplying each division to at least one element of its respective electric motor, commutating the current of each division and varying the speed of the train by varying the net effective E.M.F. of the low-tension energy. Another claim relates to a method of controlling an electrically propelled train comprising a plurality of vehicles, consisting in producing on one of the vehicles an E.M.F. for producing a current in a controlling circuit, transmitting the current to another of the vehicles, and controlling from that vehicle the current in the circuit, and thereby controlling the movement of the train. A third claim relates to a method of operating a train consisting in generating electrical energy at a stationary source, transmitting the same to the train, leading it upon the train by means of moving contacts, transforming the energy into a plurality of divisions on different locomotive units of the train, supplying these divisions of the energy to at least one element of the respective locomotive units and simultaneously controlling the transformed energy to control the train.

A NEW INSULATOR.

Electrical engineers will be interested to learn that an influential company, of which Lord Tenterden is chairman, has been formed to exploit the extraordinary substance which, under the name of "Seagumite," is being manufactured from common seaweed under a process discovered and perfected by a London chemist. It is one of the most remarkable properties of this new product that besides being damp-proof, acid-proof and germ-proof and insensitive to changes of temperature, it is also uninflammable and possesses a greater capacity for electrical resistance than vulcanite, while it can be produced at half the cost. In this matter of electrical resistance, the claims of Seagumite, it may be remembered, were at the outset the subject of a certain amount of scepticism, but the tests made at the Westminster Electrical Laboratories have not only established these claims, but have shown that its efficiency in this respect increases when the material is immersed in water; a fact which seems to open up for it a very wide field in the electrical world and especially in connection with deep sea cables. At the Westminster Laboratory the samples were submitted to a test of 32,000 volts with such complete success that the experts at first hesitated to issue a report on the subject till the tests were independently verified. By a slight differentiation in the process of manufacture, this remarkable substance can be converted into a material which would seem to hold a place midway between gutta percha and leather. It can be made flexible enough for bootsoles, belting, motor hoods or tyre-covers, and hard enough for roofs, dadoes or floor cloth. And the supply of raw material is inexhaustible. A million tons of it can be had all round our coasts for the cost of carting it.

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THE GOVERNING BODY invites applications for the appointment of an Assistant Junior Demonstrator in the Electrical Engineering and Applied Physics Department. The particulars of the conditions of appointment, duties, etc., with forms of application, can be obtained on application in writing to the undersigned, to whom applications should be sent not later than 10 a.m. on Thursday, January 18, 1912.

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HOME.

BIRMINGHAM.—The Tramways Committee of the Corporation invite tenders for the supply of 50 electric tramway cars. Particulars (£2) from Mr. A. Baker, General Manager, Tramway Offices, 147, Corporation-street. January 8.

DARTFORD.—The Urban District Council invite tenders for the supply and erection of (a) one uniflow high speed vertical engine, tandem generators, and 3-wire balancer; (b) three superheaters and extensions to pipe work; (c) switchboard; (d) electrically driven centrifugal pump. Particulars, £2 2s., from Mr. J. D. Pember. Electrical Engineer. January 23.

DUBLIN.—The Port and Docks Board invite tenders for the supply of two 4-ton electric Portal wharf cranes. Particulars (£1) from Sir J. P. Griffith, M.Inst.C.E, East Water, Dublin. January 30.

HAMMERSMITH.—The Borough Council invites tenders for the supply of arc lamps suitable for fixing on consumers' premises; to work two in series, on single phase, a.c. 50 periods 110 volts. Particulars from Mr. G. G. Bell, Borough Electrical Engineer, 85, Fulham Palace-road. January 10.

RADCLIFFE.—The Urban District Council invite tenders for the supply and erection of an electrically-driven pump of the centrifugal or turbine type for the Sewage Disposal Works. Particulars from Mr. W. L. Rothwell, Engineer and Surveyor. January 13.

ROTHERHAM.—The Corporation invite tenders for the supply and erection of one 500 kw. rotary converter with control switchgear, etc. Also for the supply of three trolley vehicles suitable for use on their Rotherham and Maltby tractless tramway route, for the Electric Light and Tramways Department. Particulars from the General Manager, Rawmarsh-road. January 10.

OVERSEAS.

BILBAO.—With reference to the call for tenders for the filtration and sterilisation of the water supply of Bilbao, H.M. Consul at that place (Lord H. Hervey) reports that the time for the receipt of tenders has been extended to noon on February 1. Tenders should be addressed to the "Secretaria del Excmo. Ayuntamiento," Bilbao.

CONTRACTS.

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The Markets Committee invite Tenders for the purchase of spare plant at their Elm Street Cold Air Stores, consisting of:—

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The Committee do not bind themselves to accept the highest or any Tender.

THOMAS HUDSON.
Town Clerk.

Town Hall, Manchester.
January 3rd, 1912.

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HOME.

GLASGOW.—For the Tramways Works and Stores Committee of the Corporation. Testing transformers: Messrs. Brown Boveri & Company, Ltd; D.C.C. wire: London Electric Wire Company & Smiths, Ltd., and the British Insulated & Helsby Cables, Ltd.; V.I.R. cable: The British Insulated & Helsby Cables, Ltd.

IPSWICH.—One 1,000 kw. turbine with dynamos and switchgear for the Corporation: Messrs. Willans & Robinson, Ltd., £4,881.

SHEERNESS.—Supply and erection of gas engine and two dynamos at the Technical Institute for the Kent County Education Committee: The British Westinghouse Electric and Manufacturing Company, Ltd.

SOUTHEND.—Meters on Corporation's electric tramcars: Messrs. Ferranti, Ltd; 1,000 insulators for pier electric railway: Messrs. Doulton & Company, Ltd.

The announcement was made some little time back that the British Westinghouse Electric and Manufacturing Company, Ltd. had been successful in securing the order from the Partington Steel and Iron Company, Ltd., of Irlam, for four large turbine blowers for blast furnace work and also turbo-generating machinery. We now learn that they have also secured the contract for the supply of all motors, with their control-gear, etc., for the equipment of the new large works in question.

OVERSEAS.

AUSTRALIA.—For the Postmaster-General's Department, Melbourne: 100 miles twisted pair copper V.I.R. insulated wire: Messrs. W. T. Henley's Telegraph Works, at £17 7s. 6d. per mile. For the Postmaster-General's Department, Freemantle: Dust extractors, dessicating apparatus, telegraph and other instruments: Messrs. Siemens Bros. & Company; 30 miles tinned copper wire, £3 15s. per mile, 3 miles at £3 2s. per mile: The British Insulated & Helsby Cable Company, Ltd.; telephone cables, ten indents, aggregating 113½ miles, at from £7 17s. 6d. to £310 per mile: Messrs. W. T. Henley's Telegraph Works, Ltd.

CANADA.—Substation equipment for the Lethbridge City Council: Messrs. Siemens Bros. & Company, Ltd., $16,900; turbo generator: Messrs. Willans & Robinson, Ltd., $28,820; steam-driven exciter: Messrs. Willans & Robinson, Ltd., $3,437; boilers: Messrs. Babcock & Wilcox, Ltd., $37,100.

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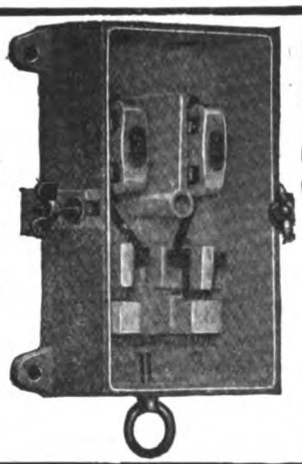

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Electrical Company Notes.

THE NATIONAL TELEPHONE COMPANY.

The report of the National Telephone Company, Ltd., for the half-year ending December 31, 1911, to be presented at the meeting on Monday next, states that the inventory of the Company's plant and assets to be purchased by the Postmaster-General is nearing completion. It is expected that the Company's claim will be ready for presentation in the early part of the year, and, in default of settlement, will, as soon as possible thereafter, be submitted to the Railway and Canal Commission, the arbitrators appointed to settle disputes in connection with the matter, between the Postmaster-General and the Company. Under the heads of arrangement referred to, the Postmaster-General has agreed, when required by the Company, to advance £3,000,000 in order to enable the Company to satisfy the claims of its debenture stockholders. It is desirable that these claims should be met as early as possible, and for that purpose it is necessary for the Company to go into liquidation. The Board have accordingly issued notices for an extraordinary general meeting of the Company, to be held immediately after the ordinary general meeting, for the purpose of passing the requisite winding-up resolutions. The procedure thus indicated does not allow sufficient time for the preparation and issue of the accounts of the Company for the half-year in accordance with its former practice. The board feel, however, that the shareholders will desire to have their usual dividends at as early a date as practicable, and having satisfied themselves that the profits of the Company for the half-year fully justify the payment of a dividend at the same rate as in recent half-years, they will recommend the payment for the half-year of a dividend at the rate of 6% per annum on the first and second preference shares, 5% per annum on the third preference shares, 6% per annum on the preferred stock, and 6% per annum on the deferred stock, less income tax in all cases. The accounts for the half-year ending December 31, 1911, will be made up as quickly as possible, and sent to the shareholders early in February next. The board have to lament the death, in November last, of their esteemed colleague, Sir Cuthbert Quilter, Bart., who from the foundation of the telephone enterprise in this country had been actively associated with it.

ELECTRIC SUPPLY PUBLICITY COMMITTEE.

The Electric Supply Publicity Committee are making a further issue of literature. We notice that cooking is still to the fore. There is an especially good cooking pamphlet, having a considerable amount of valuable data, which ought to be of very great use to supply authorities. The data is mainly concerned with the shrinkage of meat. The comparison of the large shrinkage under coal and gas cooking compared with the small shrinkage under cooking by electricity is brought out very forcibly in a diagram and also in tabulated figures. The figures are certainly most convincing and are worked out in a manner easily understood by the lay mind. The cooking pamphlet comes at a very opportune moment, when the undertakings are so anxious to push this particular use of the supply. There is also a cooking mail-card in colour, which should serve as a continual reminder to consumers of this extra use of the supply. Another Apparatus Booklet is also notified, which is a continuance of Apparatus Booklet No. 1, issued some time ago. This present one is of handy size, suitable for enclosure with correspondence, etc. It is got up in a very tasteful fashion and shows various apparatus which can be used from the supply. There is also included a Hairdressers' Circular, fully illustrating and explaining the various uses to which hairdressers can put the supply. This ought to be particularly advantageous, as electricity should be found most useful to hairdressers, if the various apparatus be brought to their notice.

Diary.

MONDAY, JANUARY 8.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (Metropolitan Centre).—Paper, "Precautions Against Fire," Mr. A. J. Stubbs, 6 p.m.

INSTITUTE OF MECHANICAL ENGINEERS (Graduates Association).—Paper: "Oil Engines." Mr. G. R. Dalkin. Chairman, Captain H. Riall Sankey, Member of Council. 8 p.m.

TUESDAY, JANUARY 9.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Local Section).—Paper, "Illumination," Mr. J. B. MacKenzie, 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students Section).—Paper, "The Performance of Single-phase Commutating Motors," Mr. G. P. Willoughby, 7.30 p.m.

WEDNESDAY, JANUARY 10.

INSTITUTION OF ELECTRICAL ENGINEERS (Birmingham Local Section).—Paper: "Dynamos for Motor Road Vehicle Lighting." Mr. J. D. Morgan, Associate.

THURSDAY, JANUARY 11.

RUGBY ENGINEERING SOCIETY.—Paper, "Air Compressor Efficiency," Mr. B. M. Woodhouse, 8 p.m.

FRIDAY, JANUARY 12.

MIDLAND ELECTRICAL ENGINEERS.—Ball, Grosvenor Suite, Grand Hotel, Birmingham, 8.15 p.m. to 2 a.m.

To be kept well posted up with the latest developments of
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THE
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which deals with the technical and commercial sides of Wireless Telegraphy.
PRINCIPAL CONTENTS FOR JANUARY:
The Measurement of Condenser Losses, by Dr J. A. Fleming; Descriptions of the Spanish and Coltano Stations; Wireless and the Wreck of the "Delhi"; Atmospherics in Southern Latitudes, etc.
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A course of 10 lectures on Illuminating Engineering will be held on Tuesday evenings, at 7.30 p.m., commencing on the 16th January, 1912. Each lecture will be given by a specialist and will deal with the principles and practical problems of the particular subject. The lectures will be adapted to a general technical audience. The following are the short titles of the different lectures:—

The Nature of Light and of Radiation.
Photometry and the Measurement of Light.
The Production of Electric Light and its Distribution.
The Chemistry of Gas Manufacture and Lighting.
The Use of Shades and Reflectors.
Physiological Factors in Illumination.
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PUBLICITY SECTION.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

"Wotan" Onewatts with Drawn Tungsten.

Messrs. Siemens Bros. Dynamo Works, Ltd., inform us that they now have on the market a complete range of "Onewatt" lamps ranging up to 250 volts, and up to 600 c.p., made in the usual grades with filaments of absolutely pure drawn Tungsten wire. Hitherto, they had only placed upon the market certain candle powers in certain voltages of this type of lamp, owing to the fact that the great demand for "Tantalum" lamps caused a congestion in their works which precluded the possibility of at once placing upon the market a full range of lamps, and at the same time avoiding the delays in delivery which are so objectionable both to the trade and to the consumer. Extensions of their works and the acquisition of fresh stores have enabled them to accumulate a sufficient stock of "Onewatt" lamps to justify placing them upon the market, and Messrs. Siemens are in a positoin to give immediate delivery of the full range of lamps, from 5 to 600 c.p. and in all voltages from 20 to 250. It is interesting to note that these excellent lamps are in future to be known as "Wotan" (onewatt) lamps, and fresh and attractive literature has been prepared embodying this alteration, of which quantities overprinted with contractors' names and address, will be forwarded post free on application to the company's works at Tyssen-street, Dalston. With a view to securing the co-operation of the trade in respect of the "Wotan onewatts," Messrs. Siemens Bros. are entering upon an extensive advertising campaign not only in the electrical press, but also among consumers.

"Tantalum" Prices Reduced.

As from the first day of the New Year, Messrs. Siemens Bros. Dynamo Works, Ltd., announce some important alterations in the price of "Tantalum" lamps. The high voltage lamps of 15, 25, 32 and 50 c.p. have now been reduced from 3s. to 2s. 6d. subject to the usual discounts, while the low voltage lamps (20 to 40) for 5, 10, 16 and 25 c.p. are now listed at 1s. 6d. These reductions have been made possible by recent improvements in manufacture, which not only enhance the efficiency and durability of the lamps, but at the same time reduce the cost of production. As in the case of "Wotans," a variety of fresh literature has been prepared, and on notifying Messrs. Siemens Bros. Dynamo Works, the trade can obtain these folders and pamphlets overprinted with their name and address free of charge. On request they will send various specimens of this literature in order that the trade may make a selection of the most effective forms. It should be pointed out that the reduction in the price of high voltage "tantalum" lamps can hardly be considered as a "price cutting move," as there is now the same difference between the price of high voltage "Tantalum" lamps and of high voltage Tungsten lamps as existed previous to the reduction of Tungsten lamps, which took place on November 16 last.

"Economical" Turn-Down Lamps.

It is interesting to note that the popular "Economical" turn-lamps supplied by Messrs. William Geipel & Company, 7, Vulcan Works, St. Thomas-street, S.E., were fitted in the private cabin of Her Royal Highness the Princess Royal on the P. and O. liner Delhi. These lamps, it will be remembered, have two filaments, one of either 8 or 16 c.p. and the other of 1 c.p., and by means of a push-button or pulley string, either filament may be switched into use. This is, of course, very convenient and economical for bedrooms, nurseries, sick rooms, passages, hospitals, railway or steamship sleeping berths or any other locality in which it is desirable to maintain a small light with the advantage of being able instantaneously to raise it to higher illuminating power. When the light is turned down a saving of 80% in consumption of current is effected, while at the same time the life of the lamp is enormously increased. These duplex lamps are listed at 2s. 6d. each, complete with switch and cords or button, ready to fit in any ordinary socket.

The "Neckar" Apparatus.

Messrs. Robert Boby, Ltd., of 212, Upper Thames-street, London, E.C., have recently issued a new illustrated catalogue of the "Neckar" water-softening and boiler mud extracting apparatus, copies of which will be forwarded on request. The special features of this apparatus are that the highly concentrated liquid drawn continuously from the boiler in a small quantity removes all scale-forming material from the heated plates or tubes, thus permitting all the heat of the coal to be more effectively transmitted to the water; the heat contained in the water thus conveyed to the softener is fully and completely utilised in raising the temperature of the water under treatment; the increased temperature of the water undergoing the softening process considerably reduces the quantity of reagent required to maintain the necessary chemical processes in full vigour, and the filtering medium is maintained in the best condition for entrapping all solids held in suspension. While costing less for maintenance and chemicals, and demanding practically no attention, it is claimed that it purifies and softens water more efficiently than other types of apparatus.

PERSONAL.

Mr. H. B. Renwick, formerly general manager and secretary of the County of London Electric Supply Company, Ltd., has been elected to a seat on the board and appointed managing director. Mr. F. C. McQuown, formerly assistant secretary, has been appointed secretary to the company.

Mr. W. B. Cownie, formerly general manager and secretary of the National Electric Construction Company, Ltd., 3, Laurence Pountney Hill, E.C., has been appointed managing director of the company, the old title, therefore, falling into disuse. Mr. Robert Watson, formerly accountant, has been appointed secretary of the company.

Mr. J. S. Pitcaithly, who has been created M.V.O. by His Majesty in connection with his work as superintendent of the electrical arrangements at the Durbar Court at Delhi, is a native of Dunheld, and was formerly with Messrs. Bruce Peebles & Company, of Edinburgh. He was appointed Electrical Inspector to the Government of the United Provinces some 18 months ago.

With the transfer of the telephone to the Government, Lieutenant-Colonel Chambers, the northern provincial superintendent, has retired from the National Telephone Company's service, in company with ten other principal officials of the company—six provincial superintendents and four of the head officials in London. As a matter of fact, only two of the existing provincial superintendents are being taken on by the Post Office, the reason assigned being that the scale of salaries paid by the old company is higher than the Government care to pay. Colonel Chambers thus ceases to have charge of the Northern Counties of Yorkshire, Durham, and Northumberland, together with part of Westmorland, after a period of service with the National Telephone Company stretching back more than thirty years. He was first local manager in Leeds, then manager of the district, from which he was promoted some years ago when control was decentralised to be the head of the northern province. He will, however, continue to live in Leeds, and will still maintain his active association with the Territorial Army in the capacity of colonel of the Army Service Corps for the West Riding Division. Part of the new scheme of management instituted by the Postmaster-General is to abolish the office of provincial superintendent, and centralise control in London through the district managers. For the present, however, Mr. Morten will continue to fill this office in Leeds, and so far as the subscribers are concerned the change of control from the company to the Government will make no immediate difference.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1911-12.	1910-11.	Week.	Current year.	1911.	1910.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Dec. 27	1,398	1,357	+ 40	+ 2,514	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5· 3
Ayr Corporation	Aug 12	550	572	— 22	—	8	8	—	—	—	—	—	—	—	—
Birkenhead Corporation	Dec. 31	1,221	1,239	— 18	+ 1,538	24·089	24·089	Mar 31	56,713	12,544,501	1,207,761	1·089	11·13	2,315	6·74
Birmingham Corporation	Dec. 23	10,953	8,244	+ 2,709	+ 65,890	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Aug. 23	1,304	1,002	+ 302	+ 2,392	14·62	—	Mar. 25	58,367	10,310,965	1,041,021	1·27	12·60	3,915	·36
Blackpool Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Dec. 30	397	359	+ 38	+ 2,161	—	—	Dec. 31	35,210	2,939,144	592,312	—	—	—	—
Bolton Corporation	Dec. 24	2,574	2,616	— 42	+ 6 232	46	42	Mar. 31	121,707	27,018,149	2,641,292	1·08	11·05	2,897	6·58
Bournemouth Corporation	Dec. 27	1,769	1,823	— 54	— 255	30	21·95	,, 31	89,695	14,686,368	1,782,706	1·46	12·07	3,066	7·76
Bradford Corporation	Aug. 5	5 573	5,706	— 133	+ 8,201	100	54·81	—	—	—	—	—	—	—	—
Brighton Corporation	Dec. 31	921	892	+ 29	+ 2,293	9·5	—	,, 31	49,124	10,708,184	1,126,676	1·101	10·464	2,857	—
Bristol Tramway Company	Dec. 29	8,011	7,673	+ 338	—	57	57	Dec. 31	308,615	47,454,560	5,914,713	—	—	—	—
Burnley Corporation	Dec. 30	1,576	1,459	+ 117	—	22	22	Mar. 31	65,295	12,911,113	1,203,118	1·21	12·41	6,067	7·89
Burton Corporation	Dec 31	272	296	+ 24	+ 568	10	6½	,, 31	15,368	3,131,172	432,911	1·07	7·75	1,416	6·41
Cardiff Corporation	Dec. 23	2,686	2,554	+ 132	+ 6,983	17·35	17·35	,, 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Central London Railway	Dec. 30	3,778	4,340	— 562	— 17,331	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,780	2·01	5·769	55,404	30·27a
City and South London Railway	Dec. 31	3,794	4,146	— 352	— 963	7·26	7·26	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Dec. 31	214	154	+ 60	+ 593	9·89	9 89	Dec 31	25,497	5,704,071	899,173	1.07	6·80	2,578	—
Croydon Corporation	Dec. 22	1,845	1,846	— 1	+ 4,756	11⅜	—	Mar. 31	85,806	19,476,576	2,269,500	1·057	9·07	4,428	—
Darwen Corporation	—	—	—	—	—	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Dec. 23	238	213	+ 25	+ 1,393	7	7	,, 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Nov. 10	109	111	— 2	— 51	7	7	Dec 31	7,472	449,677	146,081	4·0	12·27	1,067	8·38
Dublin U.T.	Dec. 29	5,534	5,597	— 62	+ 11,942	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	July 19	1,238	1,210	+ 28	— 83	28	—	May 15	62,328	16,843,909	1,322,894	·87	11·30	—	7·28
East Ham Corporation	Dec. 30	1,156	1,114	+ 42	+2,345	15	14	Mar. 31	53,287	16,059,912	1,303,753	·78	9·81	3,750	7·57
Glasgow Corporation	Oct. 28	20,029	18,102	+ 1,927	+ 28,426	196	195½	May 31	893,591	222,730,571	20,974,016	·96	10·22	4,706	5·75
Gloucester Corporation	—	—	—	—	—	15	—	—	—	—	—	—	—	—	—
Halifax Corporation	Sept. 5	2,186	1,954	+ 232	+ 5,375	37·171	37	Mar. 31	92,609	17,067,856	1,909, 97	1·30	11·64	2,456	—
Huddersfield Corporation	Aug. 19	2,298	1,965	+ 300	+ 4,324	29	28½	,, 31	96,185	19,001,660	2,058,663	1·22	11·21	3,375	6·31
Hull Corporation	Dec. 30	3,264	3,042	+ 221	+ 6,226	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Sept. 2	545	526	+ 19	+ 5	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Dec. 27	135	133	+ 2	+ 89	4	4	,, 31	7,214	1,968,850	193,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,855	5·26
Lancashire United Tramways	Dec. 27	1,517	1,807	— 290	+ 2,221	39	39	Dec. 31	68,689	13,755,329	2,272,765	—	—	—	—
Leeds Corporation	Sept. 9	7,689	7,174	+ 51	+ 12,730	108	108	Mar. 31	357,610	78,385,015	8,152,990	1·08	10·41	3,311	5·42
Leicester Corporation	Dec 30	2,782	2,592	+ 189	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Dec. 23	13,700	12,868	+ 832	+ 19,500	116	109	Dec. 31	582,276	125,507,283	12,235,408	1·106	11·42	5,020	7·955
Liverpool Overhead Railway	Dec. 31	1,333	1,330	+ 3	+ 2,342	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Dec. 20	44,985	44,148	+ 837	+ 86,220	140½	132½	Mar. 31	1,891,035	418,317 377	39,545,512	1·06	11·48	—	6·42
London Electric Railway	July —	60.847	58,978	+ 1,208	—	21·25	21·25	—	—	—	—	—	—	—	—
Lowestoft Corporation	Dec. 30	164	150	+ 14	+ 39	3½	—	Sept. 30	10,896	2,377,316	329,958	1·07	7·9	2,179	6·82
Maidstone Corporation	Mar. 6	157	100	+ 7	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Nov. 11	15,529	14,836	+ 693	+ 27,809	183	183	Mar. 1	810,094	165,800,077	17,367,200	1·16	11·19	4,667	7·17
Metropolitan District Railway	Dec. 30	11,542	11,238	+ 304	+ 13,131	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Dec. 31	18,136	17,909	+ 227	— 3,674	24½	24½	Dec. 31	718,089	102,849,458	—	1·48	—	—	—
Nelson Corporation	Nov. 4	173	144	+ 29	+ 1 225	2½	2½	Mar. 31	7,576	2,118,878	203,708	—	8·93	—	—
Newcastle-on-Tyne Corporation	Nov. 11	4,203	3,790	+ 418	+ 9,683	60½	59½	,, 31	206,130	45,335,207	4,437,639	1·09	11·15	3,421	—
Newport (Mon.) Corporation	Nov. 4	681	650	+ 31	+ 877	14½	14½	,, 31	35,146	8,452,562	895,238	·99	9·42	2,425	—
Oldham Corporation	Aug. 13	2,137	1,886	+ 227	+ 2,543	30½	35	,, 25	97,842	19,125,202	1,893,777	1·15	12·399	2,653	8·817
Portsmouth Corporation	April 29	1,788	1,783	+ 5	— 1,240	15½	28½	Mar. 31	102,978	23,053,717	2,291,767	1·10	10·15	—	—
Reading Corporation	April 27	570	556	+ 13	+ 171	13½	13½	,, 31	32,506	7,834,575	909,439	·96	8·28	4,183	4·98
Rochdale Corporation	Sept. 9	1,539	1,296	+ 243	+ 4,823	27	20·93	,, 31	63,000	11,360,871	1,402,532	1·31	10·774	—	—
Rotherham Corporation	Aug. 31	655†	645	+ 10	+ 1,412	12	9·39	,, 31	33,313	6,960,178	722,393	—	11·06	—	—
Salford Corporation	Sept. 4	4,872	4,907	— 37	+ 6,056	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	April 23	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Nov. 12	6,420	6,106	+ 313	+ 13,606	40	40	Mar. 25	316,739	84,500,331	7,618,383	·900	9·978	4,144	—
Southampton Corporation	Aug. 16	1,471	1,281	+ 190	+ 3,372	18	18	,, 25	52,647	10,121,887	1.157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 2	980	1,253	— 273	+ 1,489	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Aug. 6	1,594	1,553	+ 41	+ 3,128	20	20	,, 31	58,889	14,561,672	1,451,906	·97	9·73	2,944	—
Swindon Corporation	Nov. 8	155	138	+ 17	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	—	—	—	—	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey Corporation	Dec. 23	1,133	1,021	+ 112	+ 5,703	12·68	12·45	Mar. 31	49,835	9,990,653	1,059,629	1·19	11·28	3,971	—
Warrington Corporation	Dec. 28	498	465	+ 33	+ 476	9½	9·656	,, 31	20,169	5,266,980	435,774	·915	10·939	2,064	6·281
West Ham Corporation	Mar 28	2,445	2,250	+ 195	—	27·8	27·8	Mar. 31	127,066	36,846,649	2,907,805	·801	10·21	4,518	7·22
Wolverhampton Corporation	Aug. 23	986	917	+ 69	+ 1,418	25	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6.509

a Train Miles. † Half-years' figures.

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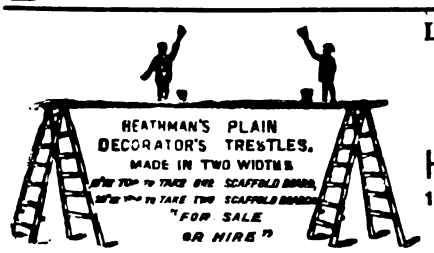

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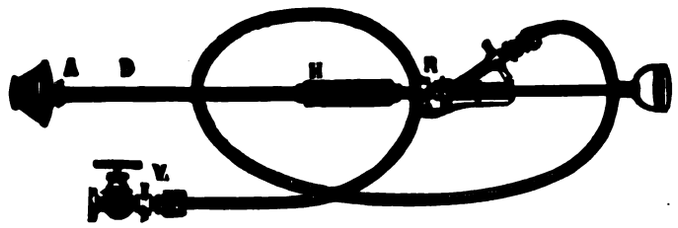

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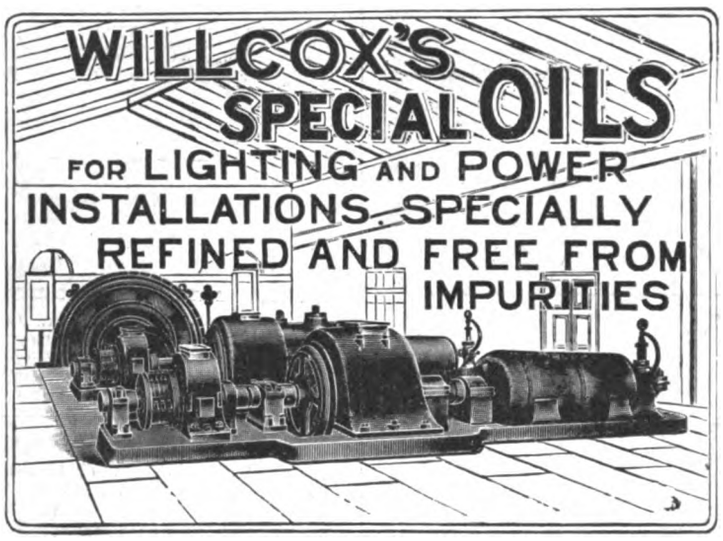

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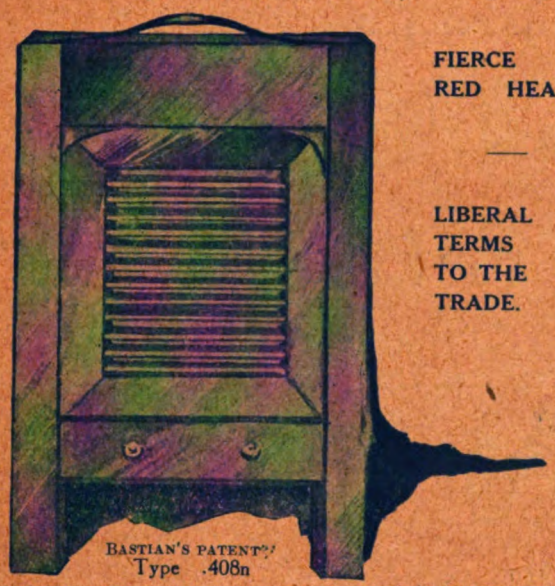

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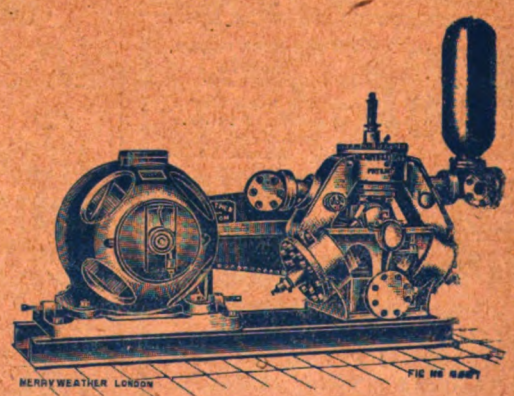

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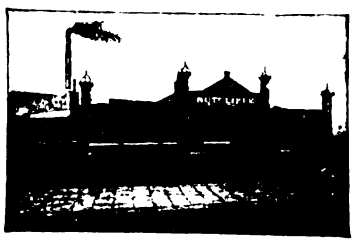

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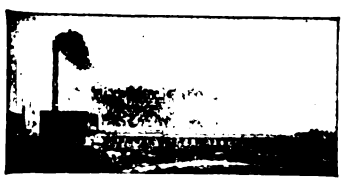

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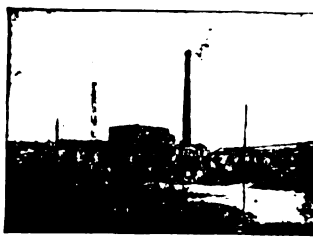

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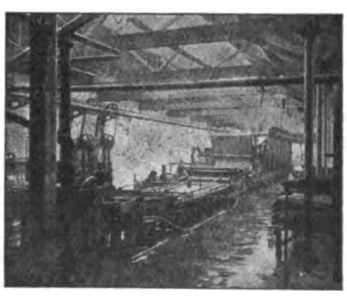

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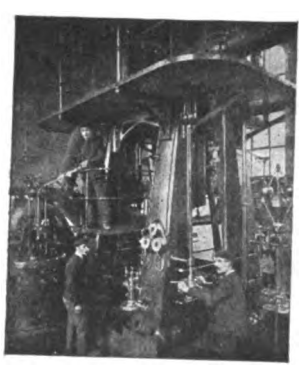

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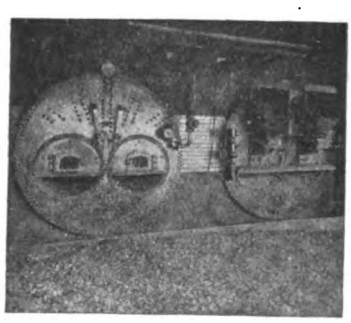

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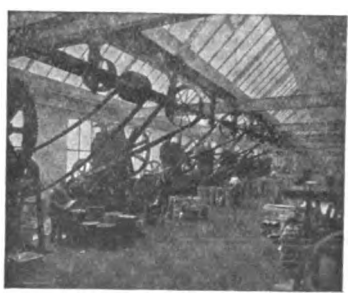

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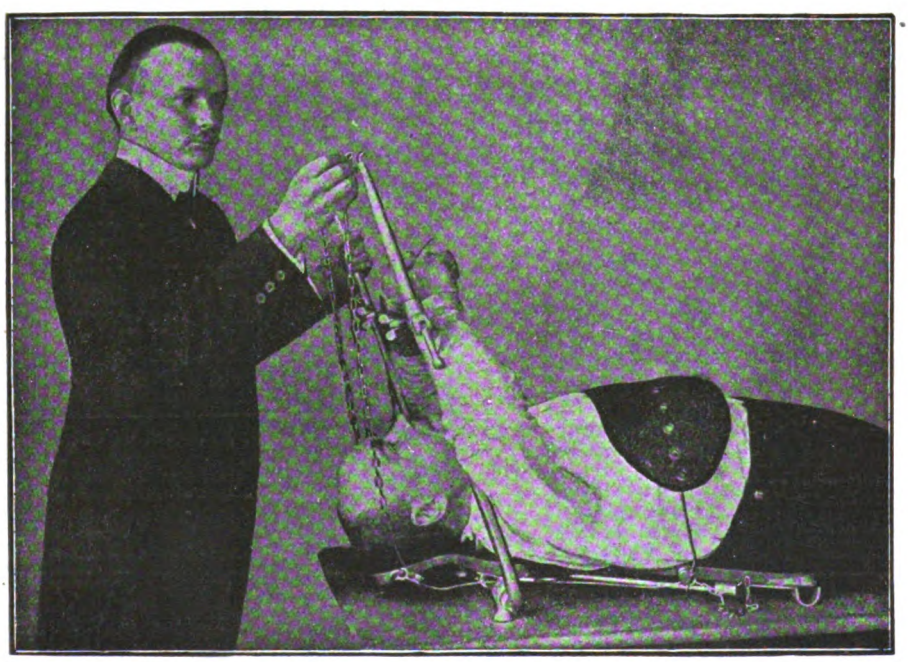

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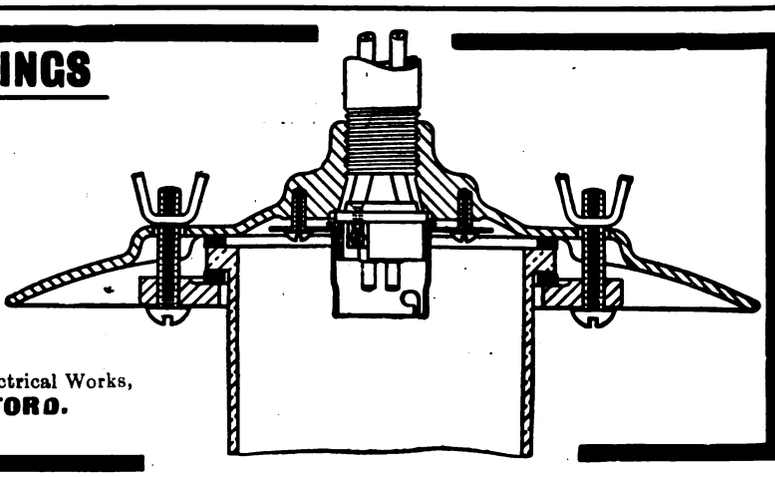

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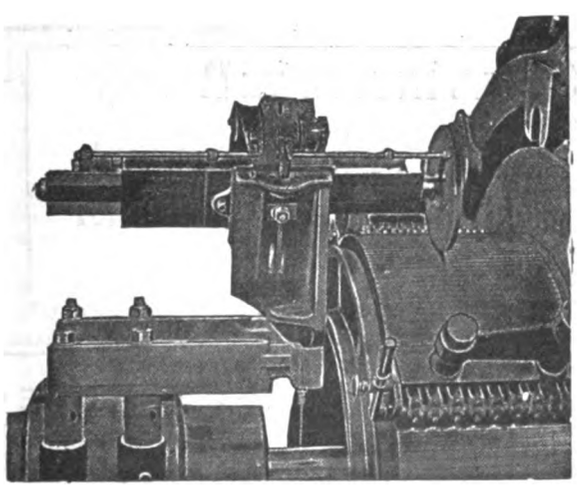

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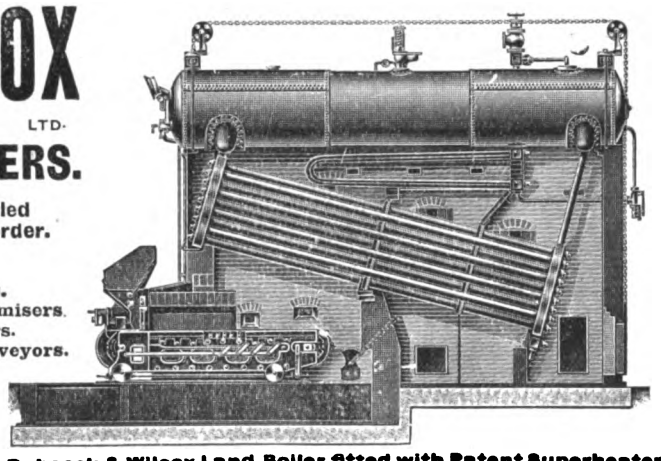

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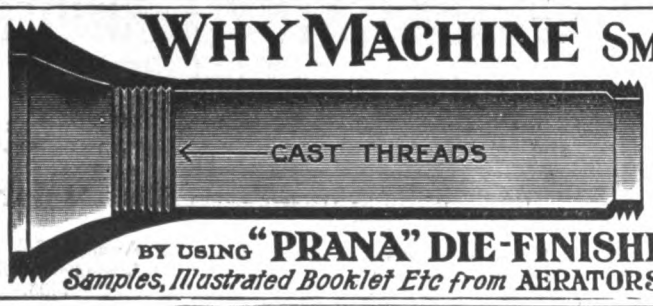

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NOTES.

EXCEPT in so far as the electrical industry is concerned, the Board of Trade returns for the past year show an increase under almost every head; certainly (with that one unhappy exception) under every head of importance. The exports of the twelve months show an aggregate value of £454,282,460, or £23,897,688 in excess of 1910, itself a record year; while imports show a total of £680,559,175, an increase of £2,302,151. Only in re-exports of foreign and Colonial produce was there any decline. This amounted to £1,196,800, or one per cent., and is no doubt due in large measure to the dock and railway strikes, Hamburg and Antwerp reaping the advantage which should have accrued to London and Liverpool. Under electrical goods and apparatus (other than machinery and telegraph and telephone wire) the falling off in exports in December alone was £383,059, the month's figures being: December, 1910: £605,278; December, 1911: £217,219. Taking the electrical trade for the whole year, the decrease in the value of exports was £1,278,331. Under imports of electrical goods the decrease for the month was £60,806, the total decrease for the year being £251,111.

AS we indicated last week, however, there is a general and very widespread feeling that the period of depression in the electrical trade is now over. Already many heavy orders have been booked for generating plant, and in the north some important mill conversions are projected. In many other directions increased activity is foreshadowed, and in view of the fresh impetus given to railway electrification and numerous traction propositions involving large capital outlay, the anticipations of a general revival in all branches of the industry appear to be based on sound premises. Even the "Times" engineering correspondent (to whose somewhat pessimistic view of things in general amiable reference has occasionally been made in these columns) declares that the prospects of general electrical progress are brighter than for many years past. Electricity alone, he says, can satisfy the demand for the richer life in so far as that can be attained by swifter travel, intensified production, and domestic comfort. "The first glimpses of what can be done to stimulate vegetable growth and to mitigate disease are alone sufficient to justify the most hopeful expectations of, as it were, a reinvigorated and more bountiful nature, while in the less sympathetic, but no less admirable, experimentation with electricity in the treatment of metals there is again promise of enormous accession of material wealth. The admitted wastefulness, generally accompanied by more or less debilitating conditions, that exists in many departments of industry, will sooner or later be avoided by electrical applications which will solve not only industrial but many household problems." And he adds that with less pessimism within the electrical trades and professions and with a readier appreciation on the part of the general public, the pace at which the promises of electricity will be fulfilled should undoubtedly be greatly accelerated. In his view, the activity of the market for generating plant and the revival of the Manufacturers' Association are the most encouraging phenomena of the past year so far as makers of machinery are concerned. The total production of steam turbine sets must have been considerably in advance of the figures for any previous twelve months,

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and could have been further increased but for a shortage in capacity which has caused general delay in deliveries. "There is no reason," he says, "to suppose that this greater demand is merely a temporary 'boom.' On the contrary, there is increasing reason to believe that there are probably thousands of reciprocating steam engines now installed that are destined to be replaced, or at least to be supplemented, by the rotary engine, which among its advantages possesses alone the ability to turn to account very low pressure steam." These general views are echoed in numerous other quarters; and the outlook generally is a very hopeful one.

IN the North this optimism is reflected on all sides. The electrical equipment of collieries is making good headway, steam plant is earmarked for scrapping in many factories where electric drive has been determined upon, and as every successful application of motors is reported upon, other factory owners fall promptly into line and modernise their equipment with eminently satisfactory results. The shipbuilders on the Clyde are placing orders for electric heaters for practically all the new passenger steamers now under construction, and the specifications also include electric winches and capstans, and electric steering gear also promises to make itself practically indispensable. The electro-hydraulic system of Dr. Hele-Shaw and Mr. Leigh Martineau, which was installed on the Orient liner Orama, has amply demonstrated the steam-saving capabilities of this form of steering gear, and for this and other forms of electrically-operated gear a large future is opening up.

REFERRING in a recent note in these columns to the "Synchron" Apparatus for the promotion of artificial respiration and the restoration of life in cases of apparent death from electric shock, mention was made of the fact that several correspondents who had written to the ELECTRICAL ENGINEER spoke of handling 200 and 220 volts with perfect safety. In replying to these correspondents numerous instances were cited from the report of Mr. Nelson, the Electrical Inspector of Mines, in which death had resulted from contact with these comparatively low pressures—fatalities which might possibly, and indeed probably, have been avoided had a "Synchron" machine (which needs no expert knowledge for its operation) been at hand. Writing in the "Journal of Electricity, Power and Gas," of San Francisco, Mr. C. A. Copeland mentions the case of a healthy man who, while in his bath, received a severe shock (from which he suffered for several weeks) while turning on the incandescent light, the pressure being only 27 volts, and another in which a student at Stanford, U.S.A., was killed on a 110-volt circuit, while other persons have received shocks from 33,000 volts which have not proved fatal. There have also been cases of direct ground shocks due to 60,000 volts which have not caused death, though many deaths have occurred from 2,000 volts. From this Mr. Copeland concludes that currents of 30,000 volts are safer than those of 2,000 volts. This, however, is a very hazardous conclusion to risk, and would seem to eliminate altogether the question of the conditions under which the shock was received. Elsewhere Mr. Copeland is on firmer ground. He points out that in the United States, whatever may be the case elsewhere, the vast majority of linemen know absolutely nothing about resuscitation after shock, and he is of opinion that this applies to other classes of electrical workers as well. Telephone linemen are said to be the most careless class of all electricians, which is probably due to companies employing men who have not been accustomed to work with voltages higher than 50, nor with amperages above unity. These men, being put to work among circuits carrying 2,000 to 30,000 volts or more, with no previous knowledge of them, not only run great risks themselves, but they may cause great danger to other better-informed men who are working with them. A suggested remedy for this is to have a company physician or superintendent, or both, who will once a year at least, but oftener by preference, make trips and give proper instruction to every outside worker, so as to demonstrate how to resuscitate a person who has received a severe shock. We are glad to be able to say that in this country central station engineers are very much alive to the risks run by their workpeople, and as the ever-growing list published elsewhere in these columns will show, the "Synchron" apparatus is being installed all over the Kingdom. Among the latest orders to hand is one from the Victoria Falls and Transvaal Power Company for twelve machines, and inquiries have come to hand during the past week from upwards of eighty power stations in the provinces.

WITHIN the next few weeks there should be a further appreciable rise in East London Railway stock. The fact that with the co-operation of Lord Claud Hamilton, the East London Chairman, the Great Eastern (of which he is also Chairman) has incorporated in its Parliamentary Bill for the coming Session a clause providing for the raising of four per cent. debentures to cover the cost of electrifying the East London, is evidence that all the difficulties in the way have at length been surmounted. The estimated cost of electrification is between £60,000 and £65,000, and the other five lessee companies have agreed to join the Great Eastern in guaranteeing the four per cent. interest in proportion to their holdings in the East London. An arrangement has also, we understand, been arrived at under which the necessary power will be supplied by the District Railway and the London Electric Railways from their Lots-road generating station, while the Metropolitan will supply the rolling stock.

MEANWHILE another important development in electric traction takes the form of the extension of the Charing Cross and Hampstead Tube from its present terminus at Golder's Green to Edgware, a distance of something like six miles. Powers for such an extension were taken by the Company in their Bill of 1909, but the opening of the station at Golder's Green has had such an amazing effect upon the development of the district that new powers will now have to be sought, and these have been embodied in a Bill deposited for discussion during the coming Session of Parliament. The fields through which it was originally proposed to carry the Hendon and Edgware line are now covered with handsome villas and in consequence a wholly new set of conditions has arisen. With the exception of about a fifth of the length of the route, the extension will be an open-air line, the objections of the Midland Railway Company having been met by means of a tunnel under their line at Hendon in place of the bridging which was part of the original proposal. If the Bill passes, as to which little doubt is entertained, the summer of 1914 will probably see the new line in full operation. All that is now needed to complete the London tube system is a spur line from Ludgate Circus or thereabouts to run either westward to link up with the tubes at Charing Cross and Trafalgar Square, or northward to connect with those at King's Cross; but no steps to this end are to be taken until the Session of 1913.

ONE of our correspondents, a very well-known central station engineer, suggests that in a note in last week's issue with regard to the capital invested in gas industries we "rather overshot the mark—doubtless in an excellent cause." It appears, however, from a Parliamentary White-paper issued a day or two ago that our figures (which, as mentioned at the time, were quoted from the "Gas World") were too low rather than too high. This return, which relates to the gas undertakings of local authorities and companies in the United Kingdom for the year ended March 31 last shows that there were then in all 809 undertakings, with an authorised capital or authorised loan of £157,341,047. The receipts for the year amounted to £31,276,196, while the expenditure was £23,211,379. The number of tons of coal carbonised was

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15,397,703, and of 198,733,354 thousands of cubic feet of gas made 182,833,928,000 feet were sold. The total length of gas mains was 36,122 miles, there were 6,417,849 consumers, and the number of public lamps lighted was 720,785. The number of local authorities included in the return is 298, and the receipts of the undertakings amounted to £10,829,758, while the expenditure was £7,902,451, and the total number of consumers supplied was 2,666,146. The capitalisation of 245 electric supply companies as approximately the same period is given in "Garcke's Manual" at £46,104,326, and of 320 municipal electric supply undertakings at £44,754,454.

IT is very sad to discover that notwithstanding all these stately millions, the gas publicity organization is finding it difficult to extract the desired amount of money for advertising purposes. Reviewing the progress of the past year in regard to gas undertakings, the "Journal of Gas Lighting" had a melancholy tale to tell. "The first month of the year," said our glimmering contemporary, "saw set on foot the inauguration of a Publicity Scheme for the gas industry, under the auspices of the Institution of Gas Engineers, aided by the Commercial Sections of the District Associations. Much effort was expended in floating the scheme; and one of the surprising things about it has been the listlessness of such a large proportion of gas undertakings to a need that has developed from new conditions. New conditions have come upon us; yet many administrators still decline to take a broader view, but continue to look at things from the standpoint that applied to past and dead circumstances." Eventually the British Commercial Gas Association came into being with the object of squeezing from the various undertakings the very small toll of half-a-crown for every million cubic feet of gas sold. Up to date we understand that £15,000 has been thus subscribed, but on the receipt of a promise from the Metropolitan Gas Company, of Melbourne, of a subscription of £100 a year for three years, a fresh appeal has been made in order to shame the home undertakings into loosening their purse-strings. "Directors of gas undertakings at home who are still standing aloof from the publicity scheme," says the "Gas World," of Saturday last, "should hesitate no longer with the example of the Melbourne directors before them. It is useless to say that they cannot afford to subscribe. Looked at in the proper way, they cannot afford to stand aside. If all were to join, the individual burden would be a trifle, and the individual benefit enormous. The Melbourne directors recognize that they cannot expect to benefit to the extent of the home undertakings, and yet they are not willing to take even a little without giving something; hence their cheque for £100. With a smaller output of gas than we have, the gas people of the United States have entered upon the task of raising £50,000 for publicity purposes. We ought to be able to do better than a paltry £10,000 or £15,000." On the quantity actually sold—officially given for the year ending March last as 182,833,928,000 cubic feet—this very modest subscription of half a crown per million would yield £22,854, or on the estimated quantity sold during 1911—rather over 200,000 million cubic feet—about £25,000.

IN these painful circumstances the "Gas World" has our sympathy. Meanwhile the industry has had in the current week an unusual amount of free publicity in connection with the disaster at Ilkeston, where a gasometer containing a million cubic feet of gas exploded, and "shook the town to its foundations like an earthquake." The published accounts state that "there was a tremendous report and flames shot hundreds of feet into the air. The huge gasometer was lifted bodily and flung thirty yards away—the railway track was carried away for forty yards—walls all around were destroyed—casks of beer were blown over the tops of houses into the streets beyond—in one house every article of furniture was smashed—practically a whole row of cottages was demolished and the inmates had miraculous escapes—the plight of the people rendered homeless was pitiable, for snow was falling and the afternoon was bitterly cold—men, women and children rushed shrieking and terror-stricken from the neighbourhood—the woodwork of neighbouring buildings ignited and a huge sheet of flame made a beacon visible for miles around." Such a nice, safe thing, gas!

ONE of the German technical papers records the fact that in a municipal electric power plant in the south of Germany is posted the following notice: "To touch these wires means instant death. Anyone failing to respect this warning will be prosecuted and fined." The penalty seems a little inadequate for culpable homicide. At least something with boiling oil in it should be added.

SOME rather remarkable statements with regard to tenders have been made during the past few days in connection with the demand that the Admiralty should place an order for two new cruisers with the Thames Ironworks. It has been pointed out that for the same specification prices as wide apart as £269,000 and £312,000 have been quoted. In a smaller way of business a much more remarkable discrepancy has just been manifested in connection with the invitation of the Wrexham Electricity Department for tenders for a main switchboard. The highest tender, that of the Electrical Engineering & Agency Company, Ltd., was very considerably more than double the lowest tender, that of Messrs. Whippe & Bourne, the respective figures being £1,743 16s. and £736 5s. The Westinghouse Company's tender was £1,525 4s., that of Messrs. Johnson & Phillips, Ltd., was £1,465, that of the Electric Construction Company was £1,438, and others were: Messrs. Ferranti, Ltd., £1,385 10s. 6d.; the Walsall Manufacturing Company, £1,305 10s.; the General Electric Company, £1,197 10s.; Messrs. Crompton & Company, Ltd., £1,137 3s. 6d.; Messrs. A. Reyrolle & Company, £1,058; Messrs. Spagnoletti, Ltd., £1,003; the Electric & Ordnance Accessories Company, £788 10s.; and Messrs. Siemens Bros. Dynamo Works, Ltd., £773 10s. The accepted tender was that of Mr. Bertram Thomas, £762. Whence these widely differing estimates? Four tenders were under £800 and ten were upwards of £1,000. In every case there is evidence of careful working-out, even to the ultimate sixpence, and yet between the highest and the lowest there is a difference of upwards of £1,007. Very nearly as marked a difference appears in the tenders for a 750 h.p. three-phase induction motor for the Brighton Electricity Works. The accepted tender, that of Messrs. Siemens Bros. Dynamo Works, Ltd., was for £770. The highest tender, that of the Electric Construction Company, Ltd., was £1,305, or £535 more, and three other tenders exceeded the £1,000 mark.

It is officially announced that the German Post Office will now accept telegrams at half rates for the German Colonies, the United States of America, various towns in China, and a number of British possessions, including British India, Singapore, Aden, British East Africa, Uganda, Rhodesia, and Zanzibar. The telegrams, must be written in plain language and will be despatched after ordinary private telegrams and Press telegrams, but will rank as ordinary telegrams in cases where there has been a delay of not less than 24 hours.

During the seven years 1903 to 1909 about 110 miles of branch lines were electrified. The success of these tentative proceedings has been so great that sixteen sections of the State railways of a total length of 625 miles are in course of electrification. The water power is obtained from the south of the Alps.

The greatly augmented volume of their business has made it necessary for the ARMORDUCT MANUFACTURING COMPANY, LTD., to take additional premises at 9, Farringdon-avenue, London, E.C.

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Electricity and the Navigation of the Panama Canal.

By John Geo. Leigh.

I preface this series of articles with two, to my mind, most interesting and significant announcements. The first—founded upon a carefully-considered judgment of the Isthmian Canal Commission, and therefore entitled to the fullest respect—has reference to the date of completion of the great inter-oceanic highway which, for four hundred years, has been the dream of imaginative men of all nations and creeds. Not in January, 1915, as was estimated by the present Commission soon after it assumed control of the enterprise, but eighteen months earlier, we are now assured, the Panama Canal will be in a fit condition to pass with security any shipping which may claim its use. In the limited space at my disposal, I can but hint at the vastness of the economic revolution which is certain to follow the opening of this new route between all countries possessed of an Atlantic sea-board and the greatest of the oceans. I cannot, however, leave the subject without a word of testimony to the untiring energy and splendid organisation which have characterised the past five years of canal administration, and rendered possible this unexpectedly early consummation of America's supreme and most cherished ambition.

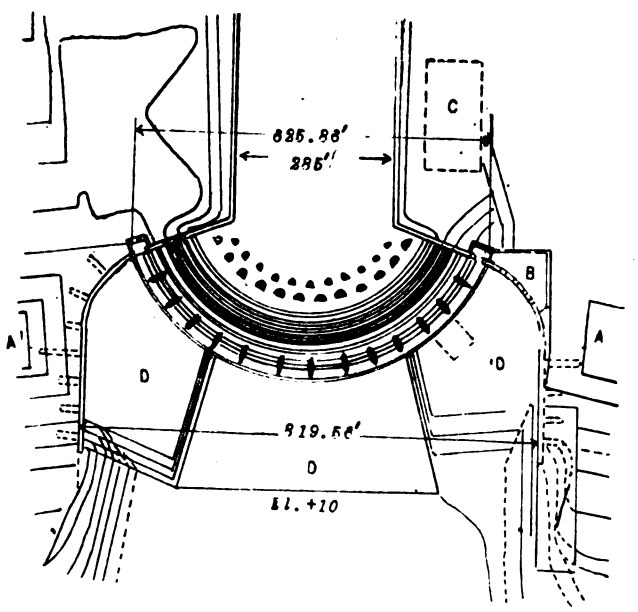

FIG. 1.—GATUN SPILLWAY DAM, SHOWING POSITION OF NEW POWER STATION.
A—Axis of Gatun Dam (El. + 115); B—Forbay for Hydro-electric Plant; C—Hydro-electric Power Station; D—Rock covered with 1 ft. of Concrete.

Though necessarily less sensational, the second announcement is by no means devoid of significance. It is to the effect, so popular has proved the decision of the American Institute of Electrical Engineers to hold its mid-winter meeting in the Canal Zone, that no fewer than 120 members have already expressed intention to take part in the proceedings. This recognition of the important *rôle* which electricity has played in the work of canal construction, and of the still more conspicuous mission of this form of energy in relation to the operation and navigation of the completed highway is no less opportune than deserved. The final stages of canal completion abound with points of interest to the electrical engineer, and I venture to express a hope that the example of their American *confrères* in making a study on the spot, may not be wholly lost upon British members of the same profession.

Soon after the transfer of the Zone and canal property to the United States, electric lighting plants were established at various points along the canal line, and these from time to time have been enlarged as the area of operations extended and the labour force increased. During 1909-10, also, two electric-generating stations were completed and placed in operation, one at Gatun and another at Miraflores. From the first power has been furnished to Gatun locks and dam for the concrete-handling plants and other constructional work, for lighting Colon, Gatun, and adjacent places, and operating the manufacturing plants of the Commissary Department at Cristobal. From Miraflores power is delivered by overhead three-phase transmission lines to the Pedro-Miguel and Miraflores locks, and to Ancon quarry and Balboa docks, respectively distant about 5½ and 4 miles. Each of these power-houses has a capacity equivalent to 6,000 h.p., and is equipped with six 400 h.p. water-tube boilers, three Curtis 1,500 kw. 2,200-volt three-phase 25-cycle turbo-generators, two 35 kw. 125-volt turbo-exciters, one 30 kw. 125-volt induction motor-driven exciter, and two 500 kw. 600-volt and one 300 kw. 600-volt rotary converters. The general arrangement of plant at the two stations is shown in the accompanying plan.

After the completion of the canal the Gatun station will be abandoned, but that at Miraflores will be held in reserve for operating purposes, in the possible event of temporary failure, due to accident or lack of water, of the hydro-electric power plant to be installed at Gatun. The purposes

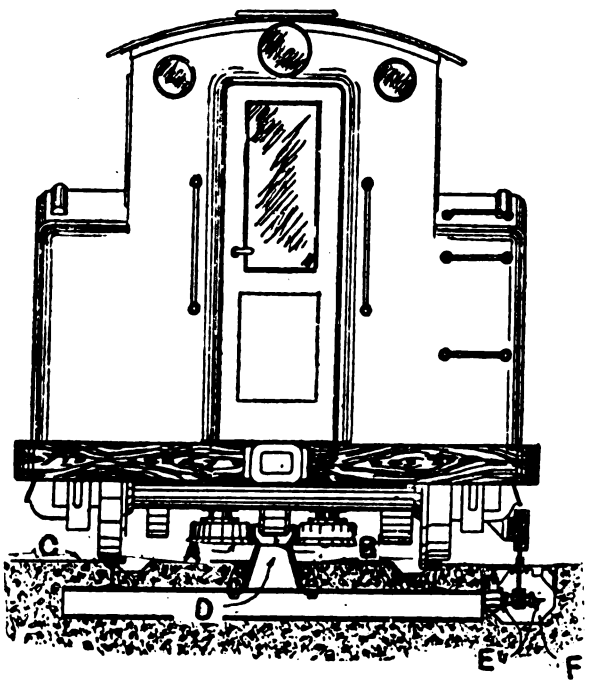

FIG. 2.—ELECTRIC TOWING LOCOMOTIVE.
End view, showing rail system, with rack rail in centre and power rail on side in open conduit. A—Thrust Wheel; B—Driving Pinion; C—Level of Coping; D—Rack; E—Conductor Rails; F—Conduit.

of this generating station will be to supply current for power to operate the gates, valves and other machinery of the locks and the regulating works of the spillways of Gatun and Miraflores dams, and, generally, to furnish light and power throughout the canal line.

The site selected for the power house is immediately below the concrete dam and the lake-level regulating works, which—with the concrete-lined and paved spillway behind—separate the east and west portions of Gatun dam. The spillway, 1,200 ft. long and 285 ft. wide, has been closed at its south, or upstream, end by a concrete dam, with foundation at sea level at the toe and at 10 ft. above sea level at the upstream end. This dam is 93·04 ft. wide from toe to heel, and 808 ft. long on the crest line across the channel, the crest being 69 ft. above sea level. It contains about 140,000 cubic yards of concrete, and on top of it are being built the lake-level regulating works. After study of the maximum flow to be cared for and the probable rate of discharge over a dam in ogee form of the above dimensions, it was determined that fourteen gates, each 45 ft. wide, with sill elevation at +69 ft., will give absolute control of the lake under all possible conditions. Each of

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the gates will weigh about 42½ tons complete, and will be identical in size and construction with those, eight in number, to be installed at the Miraflores spillway dam, which is designed to control the flood waters of various streams impinging on the east side of the canal line between the two lock flights on the Pacific slope. In each case, the individual gates will be raised and lowered by an ingenious combination of counterweights, worm-wheel nuts and worms, actuated by motors, coupled direct to driving shafts and placed in the machinery tunnels of the dams. A limit switch, geared to each driving shaft, will prevent over-travel at the ends of the travel of the screw, and allow the motor to be reversed at any point. Consequent upon the large extent and irregular dimensions of Gatun lake and the distance between the upper valley of the Chagres and Gatun dam, it is not anticipated that much drift will reach the spillway, even in time of extreme flood. The crest gates have accordingly been planned to open at elevation +92, which will provide sufficient opening for any drift likely to reach the dam to pass over. Below the dam, for the purpose of destroying to some extent the velocity of the water and destroying its shock over the concrete bottom of the spillway, there will be placed a number of masonry baffles, protected from damage by drift by heavy ribbed cast-iron plates.

spillway dam has been definitely selected. Consequently, the amount of water available for power purposes when the storage of Lake Gatun has to be drawn down—i.e., during the four months' dry season—will be 275 ft. per second, equivalent to 2,342 h.p. (theoretical), generating 1,390 kw. at the switchboard. It is estimated that, even in exceptionally dry seasons, there will be more water in the lake (in other words, the summit level of the canal) than will be required for all the lockages permitted by time. With this in mind, it has been decided to forego the additional head of 10 per cent. obtainable at the lower site in favour of an estimated saving of between £20,000 and £40,000. A considerable portion of this economy may be effected by the omission from the scheme of the proposed regulating system and, consequently, of a mezzanine floor in the power house. The contractors for both turbines and generators guarantee satisfactory regulation with flywheel effect of 600,000, without surge tank—the bearings for the rotating parts being placed on the tops of the generator cases.

Apart from the colossal dimensions of the locks and the variety and power of the operating machinery with which these structures are being equipped, perhaps the most distinguishing feature of the completed Panama Canal will be the elaborate precautions which are being adopted to

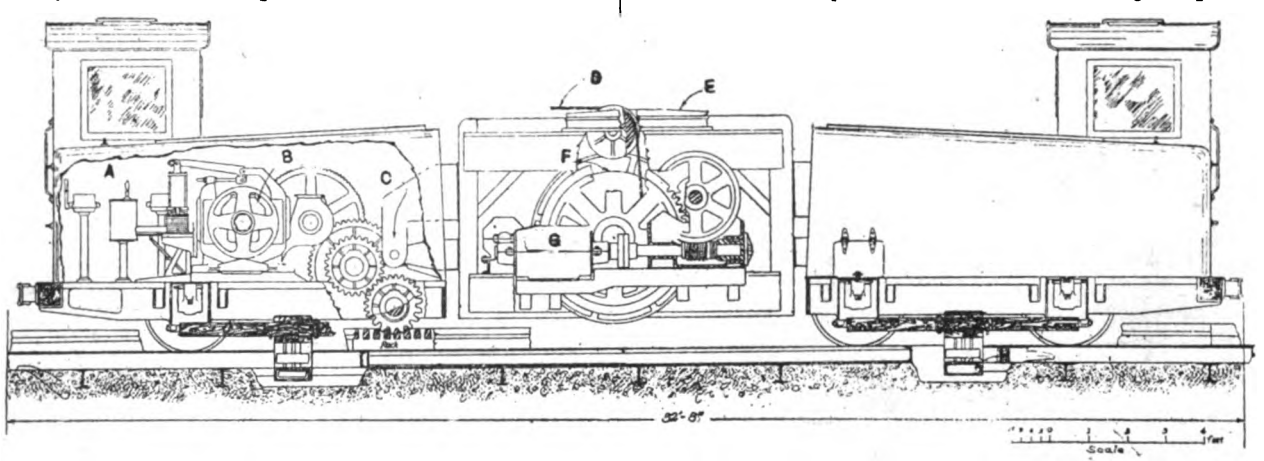

FIG. 3.—ELECTRIC TOWING LOCOMOTIVE.
Side View. One tractor, showing housing; the second tractor and windlass unit, without housing, showing the machinery with certain parts omitted to illustrate more clearly the working features. A—Controllers; B—Traction Motor; C—Universal Connection; D—Towing Line; E—Turret; F—Slip Drum; G—Winding Motor; H—Collecting Plough.

The equipment for the new generating station at Gatun, which will be situated near the head of the spillway, will include three water turbines of the unsubmerged vertical shaft type, 2,250 kw. each; three rapid-acting relay type generators; three iron and steel headgates; three penstocks, of the combination metal plate and concrete type, not less than 10 ft. 6 in. inside diameter; three compressed air regulators, or surge tanks, of the differential type; three generators of the three-phase alternator type, capacity 2,500 k.v.a. (2,000 kw.), which will be required to meet the conditions of an instantaneous variation of load equal to 50 per cent. of the full load rating; three exciter generators of the direct-current shunt-wound type; two motor-driven exciter sets of 100 kw. capacity; a gravity type lubricating system with centrifugal pumps; a 20-ton, 3-motor travelling crane; and switchboard, cable control and other fixtures. In connection with the tenders for this equipment two proposals were invited. For the first, the average difference between the water levels in the lake and in the tailrace was estimated at 75 ft., and the turbines, necessarily of the vertical type, were rated on this basis; while for the second the turbines, which might be of either horizontal or vertical type, were to be rated upon the basis of an average difference of 83 ft.

Information reaches me only at the moment of writing of the result of the competition for the supply of this plant. Three tenders, it appears, were received in respect of the turbines, and three for furnishing the generators; and these permitted eight different combinations, of which that submitted by the Pelton Water Wheel Co., of San Francisco, and the General Electric Company, of Schenectady, N.Y., was deemed the most advantageous. Accordingly, to these companies have been awarded, respectively, the contracts for turbines and generators. Of the two sites for the power house which had been under consideration, that nearer the ensure the safety of navigation.

Of these, not the least important will be the regulation prohibiting vessels from approaching the lock gates under their own power. Long piers are being provided below and above all the locks, and against these vessels will be compelled to moor before approaching within 300 ft. of the nearest gate. They will then be taken in charge by powerful towing appliances on the lock walls, and drawn through the locks under control of the canal authorities. For this purpose an electric locomotive has been designed, of which a general view is given in the accompanying drawings.

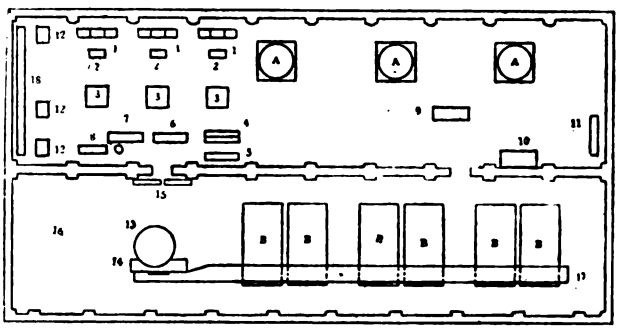

FIG 4.—GATUN AND MIRAFLORES POWER STATIONS—GENERAL ARRANGEMENT OF PLANT.
A—Turbogenerators; B—Boilers; 1—Three sets of transformers, three transformers in each set; 2—Three reactance coils, one to each set of transformers; 3—Three rotary converters; 4—Bench-board; 5—Relay and recording meter board; 6—Exciter board; 7—D.C. feeder board; 8—Air compressor motor, induced draft fan motor and station lighting transformers; 9—Feed pumps; 10—Feed water heater; 11—Motor driven air compressor; 12—Oil switches, one for each turbogenerator and rotary converter; 13—Stack; 14—Induced draft fans; 15—Oil filter and storage tanks; 16—Machine shop; 17—Breeching connecting boilers to induced fan system; 18—Feeder oil switches.

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The number of these machines required to tow a vessel through a lock or flight of locks will, of course, vary according to the size of ship; but, speaking generally, four will be employed—two ahead, one on each wall, imparting motion to the vessel, and two astern, one on each wall, to maintain the vessel in a central position and bring it to rest when entirely within the lock chamber. As will be seen from the drawings, the locomotive consists of three distinct elements—two, the front and rear, being mounted upon rigid four-wheel trucks, while the third is connected with the tractive elements by universal joints and equipped with a slip drum towing windlass and hawser. By means of the last-mentioned provision, the line can be taken in or paid out by the windlass, permitting variation of the distance between the ship and locomotive, and of a pull being exerted or relieved, without actual motion of the locomotive on the rails. This facility is eminently desirable, especially in bringing a vessel to rest or in changing the length of the towline, when, for example, the forward locomotives have advanced up the inclines of the lock walls to the level of the next lock chamber, while the water levels are being equalised and the vessel is necessarily stationary.

Speeds:

Locomotive towing	2 miles per hour.
Locomotive returning	5 miles per hour.
Slip drum towing	10 ft. per minute.
Slip drum idle	200 ft. per minute.

Motors:

Two 75 h.p. at 500 r.p.m. for driving units.
One 7½ h.p. at 750 r.p.m. for slip drum—10 ft. per min.
One 2 h.p. at 750 r.p.m. for slip drum—200 ft. per min.

Starting torque at 1 ft. rad.:

For 75 h.p. motors	each	1,150 lb.
For 7½ h.p. motors	each	100 lb.
For 2 h.p. motors	each	20 lb.

(To be continued.)

ELECTRICITY IN THE PRINTING OFFICE.

A correspondent propounds the following problem to which replies are desired:—

"A printing establishment has the following plant driven at present by 14 N.H.P. gas engine placed on ground floor: Ground floor (letterpress)—1 quad-crown, 3 double royals, 2 double demys, 2 double crowns, 3 demys, 2 crowns, 5 platens, 1 Harris (single colour); first floor (lithographic)—1 double demy, 1 double crown, 3 demys, 1 offset, 1 crown folio, 2 power transferring presses, 1 bronzer; second floor—3 guillotines, 2 folders, wiring, sewing and stitching machines; lift to take 5 cwt. from basement to top of three storey building, and a small water pump.

"It is proposed to convert to electrical drive, local power available, two-phase, 2,200 volt transform to 100 or 200. Compare first cost, economical running, maintenance, special advantages in manipulation (in the two latter methods the best manner of connecting to machine also) of the following methods: Grouping the machines and driving by two-phase motors, individual two-phase drive, and rotary converter with d.c. motor to each machine.

"It should be remembered that at times, one or two machines are required to work for a few hours after actual factory times."

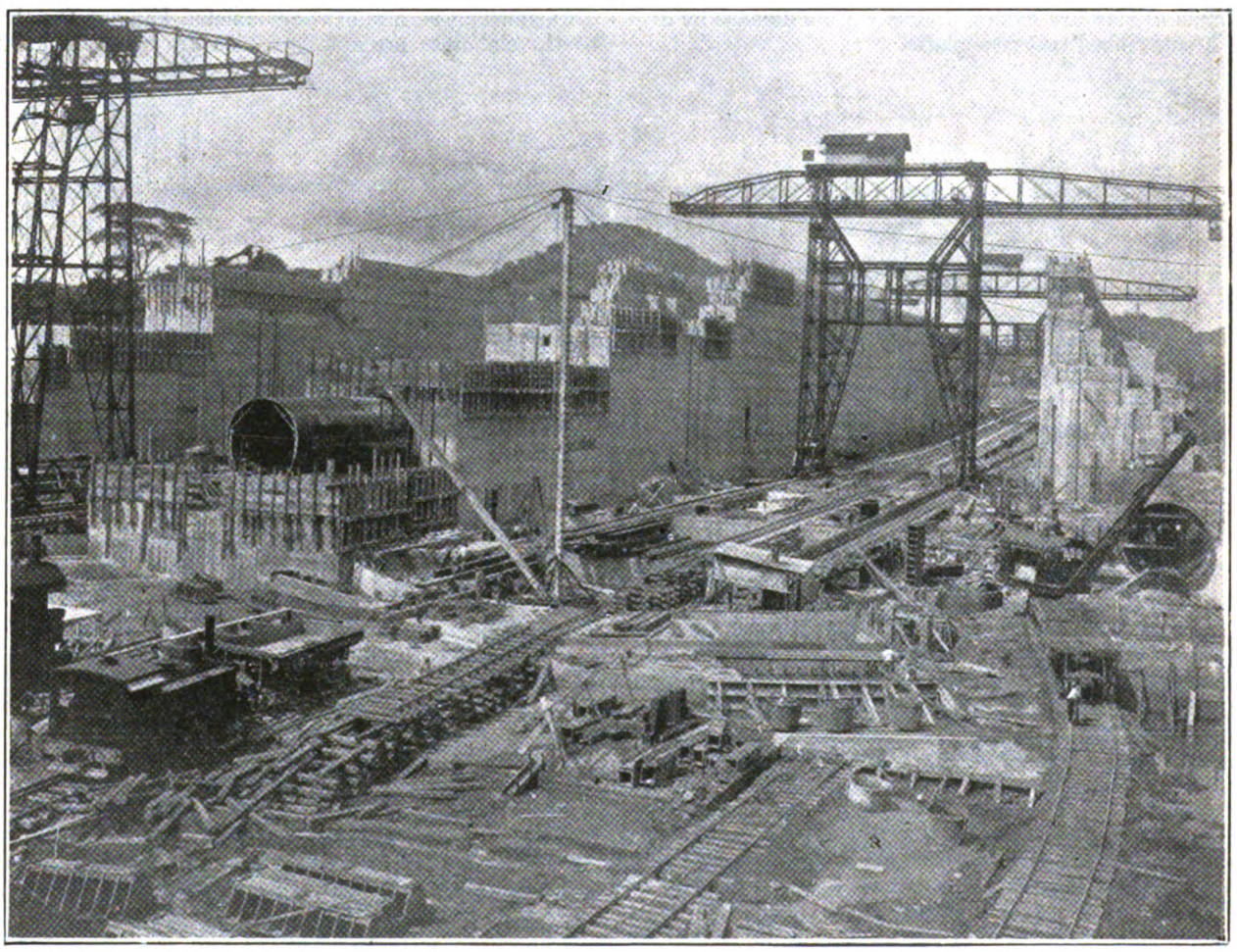

FIG. 5.—PEDRO MIGUEL.

For general purposes, however, in towing, the locomotive will derive its tractive effort from one of the end elements, through a pinion engaging a shrouded semi-suppressed rack anchored in the lock-wall coping, the side pull of the towing line being taken up by horizontal thrust wheels, bearing on the side of the rail.

Each flight of locks will be provided with two towing tracks, one on the side and one on the middle wall; and on each side wall there will be a return track, and on the middle wall a third, common to both the twin lock chambers. All these sets of rails will run the entire length of the respective flights and extend some distance on the terminal guide and approach walls, where they will be joined by a switch. Central racks are provided only on the towing tracks and inclines, the locomotives being driven on the level portion of the return tracks by friction on the side rails. The current for operation will be in all cases taken from underground conduits. The maximum pull on the towline is fixed at 25,000 lb., at which force a friction coupling will relieve further strain. Other details are appended:—

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The Institution of Electrical Engineers.

SOME GENERAL PRINCIPLES INVOLVED IN THE ELECTRICAL DRIVING OF ROLLING MILLS.

By C. Antony Ablett, B.Sc.*

The power which is required to drive a rolling mill generally varies rapidly between wide limits, while the condition that power should be generated cheaply is that the demand made for power on the generating plant should be maintained steadily at the full capacity of that generating plant. To ensure that the working costs of a rolling mill should be low, means must be found for reducing the fluctuations in the power required to drive the mill, care being taken in doing this that the capital cost of the plant is not unduly increased nor is the possible output reduced. Any reduction of the possible output is equivalent to an increase in the working cost, as the capital charges per ton are increased.

The variations in power are reduced by employing a flywheel in conjunction with the electric motor which is used to drive the rolling mill, and by providing some device for reducing the speed of the motor and flywheel to enable the flywheel to give out some of its stored energy when the demand for power is great, so as to reduce the power which has to be furnished by the motor. When the demand for power is small the motor will speed up the flywheel, thereby replacing its stored energy; this increases the power which the motor has to supply when the demand made by the mill is small, and therefore reduces the total variation in power.

The ordinary direct-current shunt-wound motor, or three-phase induction motor running at light load, will fall in speed by, say, 2% when it is required to give its full power. The stored energy of the flywheel varies as the square of the speed at which it is running, so that if a flywheel were used in conjunction with this motor it would only give up 4% of its stored energy as the power increases from light load to the full power of the motor. Continuing this argument further, suppose that the rolling mill required during a pass a power equivalent to 4 times the normal full-load power of the motor for a few seconds. Commercial motors will not give more than twice the normal full-load power for a few seconds without being liable to injury, and to prevent this the circuit breaker is usually set to open at the current corresponding to this power. The flywheel, therefore, has to furnish the power which is in excess of that which the motor can give. In the case considered, the motor would fall perhaps 5 or 6% in speed when the power increased from light load to double full-load power, so that the flywheel would only give up 10 or 12% of its stored energy. The flywheel would, therefore, have to be abnormally heavy, or else if a flywheel of a weight within the bounds of commercial possibility were adopted, the combination would be unable to cope with this demand for power, and the motor power would increase until the circuit breaker opened.

It is, therefore, necessary artificially to increase the fall in speed of the motor as the power which it has to give increases. If the speed falls by, say, 10% as the power increases from zero to full load, and, say, by 22% as the power increases to the double full-load power, the flywheel would have given up 39% of its stored energy by the time that the motor was giving double its normal full-load power, instead of from 10 to 12%. A flywheel of moderate weight would materially assist the motor in overcoming heavy demands for power which last for a short time only. In practice the maximum power given by the motor would seldom be as much as double the normal power, nor would the motor power sink to zero, as even when nothing was being rolled the motor would still have to provide the power for overcoming the friction of the mill, which is considerable.

* Abstract of a paper read before the Yorkshire Local Section, at Sheffield, Wednesday, Jan. 10, and in London on Thursday, January 11, 1912.

There are two possible devices for artificially increasing the fall in speed of the motor as the power demanded increases. These are commonly spoken of as:—(1) The permanent-slip regulator; (2) the automatic-slip regulator. This last term is misleading because both devices perform their functions automatically, the difference between them being that with the first the amount of fall in speed or the slip steadily increases as the power increases, while with the latter the fall in speed increases suddenly after a definite power is attained. It would, therefore, be better to call these devices:—(1) The continuous-slip regulator; (2) the intermittent-slip regulator. Of these the continuous-slip regulator is the device which is more commonly used in practice. It consists of an ordinary compound winding provided for the field-poles, while the intermittent-slip regulator consists of a system of relays which successively short circuit resistances in series with the shunt field winding, thus increasing the field and causing the speed to fall when the power has reached a certain predetermined point. In the case of the three-phase motor, the continuous-slip regulator consists of a resistance, liquid or metallic, permanently inserted in the rotor circuit, while the intermittent-slip regulator may consist either of a liquid resistance, the moving plates of which are controlled by a motor relay, so that the plates are raised and the rotor resistance increases when the current has reached a predetermined point, or a metallic resistance which has its various sections short-circuited by a series of relays, so arranged that these relays cut the resistance into the rotor circuit when the current has reached the predetermined limit.

Continuous-slip Regulator.

For the sake of simplicity, it is assumed that the fall in speed of the motor or slip below no-load speed is proportional to the power which the motor is giving. Within the limits of fall in speed or slip of the motor it can be assumed that the stored energy given up by the flywheel is proportional to the slip, without involving any large error, therefore the power given by the flywheel is proportional to the rate of change of the slip—that is, to the rate of change of the motor power. After the bar leaves the rolls the power which the motor gives while decreasing to the value corresponding to the friction goes to increase the speed of the flywheel, and so replaces its stored energy.

Let—

P = power required to drive rolling mill when bar is between rolls.
K_{s1} = full-load power of motor.
s_1 = slip of motor at full load.
v_0 = speed of motor at no load.
v = speed at which motor is running at any particular time.
s = corresponding slip.
I = moment of inertia of flywheel.

$$\text{Stored energy of flywheel} = \frac{I v^2}{2};$$

supposing speed of flywheel is reduced from v_0 to v,

$$\text{Stored energy given up} = \frac{I (v_0^2 - v^2)}{2}$$

or—

$$\frac{I}{2} (v_0 + v) (v_0 - v);$$

$v_0 - v$ is the slip s, and $v_0 + v$ may be put equal to $2v$ without making much error.

Stored energy given up by the flywheel is—

$$I v s;$$

that is, the stored energy which has been given up is proportional to the slip.

The sum of the power given by the motor and the flywheel must be equal to the power required to drive the rolling mill. We can express this by the linear differential equation—

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$$I v \frac{\delta s}{\delta t} + K_1 = P,$$

the solution of which is—

$$\text{Motor power } K_1 = P\left(1 - \epsilon^{-\frac{K t}{I v}}\right)$$

showing that the motor power increases according to a logarithm curve.

Similarly, when the bar is out of the rolls the motor power is equal to the power taken to speed up the flywheel, thereby restoring its stored energy, or—

$$I v \frac{\delta s}{\delta t} + K_1 = 0;$$

the solution of this is—

$$\text{Motor power } K_1 = P \epsilon^{-\frac{K t}{I v}},$$

showing that when bar is out of the rolls the motor power decreases also according to a logarithm curve.

The friction of the mill has been left out of these calculations for the sake of simplicity, but it can be very easily taken account of in drawing the curves by shifting the zero line.

The expression $\frac{I v}{K}$ expressing the relation of motor power to flywheel capacity is the " time constant " in this case and is exactly analogous to the " time constant " in the case of the heating or cooling of electrical machinery. The value of the time constant for a motor and flywheel, however, does not usually exceed about 33 seconds. The value of the time constant to be selected naturally depends on the type of mill. In a sheet mill where the duration of the passes is very short the time constant need not be so big as in the case of a bar mill, where the finishing passes may take a considerable time. The greatest time constants are found in the case of motor and flywheel for the motor-generator set of an Ilgner electrically driven reversing rolling mill.

Curves are given by the author to show the rise and fall of a motor and the variation of power and from these he deduces the following general conclusions, namely :—(1) If the time during which the pass lasts is short, and t interval is also short, light flywheels will reduce the percentage variation in power to a small value, while if the time of passes is long, and the intervals are also long, heavy flywheels are required ; (2) where the time of the interval is short compared with the time of the pass a light flywheel will enable the percentage variation of power to be kept moderate, but if the time of the interval is long compared with the time of the pass, the heavier flywheels must be used.

In practice the question is not so simple because the various passes in rolling down a billet to a definite section require widely differing powers, while the time of the passes and of the intervals also differ widely.

The effect of the errors introduced by the assumption made in the above theoretical considerations may now be considered. To simplify calculation, it was assumed that the stored energy given up by the flywheel is—

$$I v s,$$

and not—

$$\tfrac{1}{2} I (v_0 + v) s;$$

that is to say, the stored energy given up by the flywheel has been assumed to be rather too large, so that the variation of power will actually be somewhat larger than the calculated value. An error introduced in this way may be about 7% at the most. It has also been assumed that the decrease in speed of the motor is proportional to the power which the motor is giving—this also is not quite correct. In the case of a direct-current motor having a continuous-slip regulator, that is to say, a compound wound motor, the speed-power curve begins to approach that of a series motor, and as the load increases from light load the speed falls more rapidly at first than it does later on. The effect of this is to flatten the logarithm power curves for the rise and fall of power, making these curves approach more towards straight lines, and, in the case of passes of short duration, actually to reduce the variations of power. This effect becomes more marked as the compounding of the motor is increased.

With a three-phase motor having a continuous-slip regulator—that is, a resistance connected permanently in the rotor circuit—the speed falls less rapidly at first, when the power increases from light load, than it does later on. The effect of this is to increase the curvature of the logarithm power curves and to increase the variations of power in the case of passes of short duration. The consequence of this is that in certain cases a heavier flywheel must be used in conjunction with a three-phase motor than with a directcurrent motor, in order to obtain the same results.

In any mill the bar is elongated in each pass so that each successive pass taken in the same pair of rolls takes a longer time than the previous pass. Frequently less draught is taken in each succeeding pass than in the previous pass, so that the tendency is for the power diagram to consist in the earlier passes of large powers lasting for a short time, and for the power gradually to diminish and the time to become longer as the later passes are reached. There are many exceptions to this. Mention may be made of such cases as those where the bar cools rapidly, owing to the shape of its section being such as to present a large area in proportion to its weight, so that considerable powers are required for the later passes, or where heavy draughts must be taken in certain passes, so as properly to form the section, as, for instance, in the rolling of wag spokes, or in the case of a sheet or plate mill where the plate is turned at right angles after a few passes in order to broaden it, thus requiring a greater turning moment and thus a greater power, owing to the increased width of plate presented to the rolls.

Intermittent-slip Regulator.

A type of intermittent-slip regulator suitable for direct-current motors. This consists of a small motor relay which sets in operation a number of relays which successively connect resistance in parallel with the resistance placed in series with the shunt field of the motor. The field of the motor relay is excited by the main current passing through the mill motor armature. If the mill motor is small the main current passes through this field, but if the main current is too big the field is placed across a shunt placed in the mill motor circuit. The armature of this motor relay is excited by a pressure winding which is placed across the mains supplying the main mill motor. The armature is restrained from moving by means of a spring, so arranged that when the current in the main circuit exceeds a certain value, the turning moment of the armature of the motor relay overbalances the spring, so that the armature makes a slight movement. This movement of the armature successively makes contact with a number of fingers, which energise the relays, which successively connect resistances in parallel with the resistance in the main motor shunt field.

A form of intermittent-slip regulator adapted for use with three-phase motors consists of three liquid resistances with moveable plates, one placed in each phase of the rotor circuit. A motor relay is provided in this case, the windings of the motor stator being either in series with the mains supplying the main mill motor or else supplied through a current transformer. The rotor of this motor relay is prevented from moving, either by a spring or by a weight slung from a band passing over a pulley on the motor shaft. When the current in the main motor exceeds a certain perdetermined value the turning moment given by the motor relay overbalances either the spring or the weights, allowing the armature to turn a certain amount, thereby raising the plates in the liquid resistance by means of a belt passing over another pulley on the motor shaft. The raising of these plates increases the resistance in the rotor circuit of the mill motor, thereby causing it to fall in speed.

Such intermittent-slip regulators do not find much application, because they are not rapid enough in their action to deal with the extremely rapid fluctuations in power occurring in most rolling mills.

The action of the intermittent-slip regulator is very different from that of the continuous-slip regulator. This intermittent regulator comes into action when the power given by the motor attains a certain value, and when this point is reached a very slight increase in power indeed will cause the intermittent-slip regulator to act to its fullest extent. Theoretically speaking, therefore, the power can

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be maintained at its average value with a deviation of perhaps less than 1%, so that the power curve is practically a straight line, and does not rise and fall in accordance with logarithm curves, as is the case with the continuous-slip regulator.

Further, it has been shown that with such variations in speed of the motor and flywheel as are permissible in practice, the stored energy given out by the flywheel is proportional to the fall in speed. Assuming, therefore, that constant power is required throughout the pass when a bar is between the rolls, and as the power given by the motor is practically constant, the power given by the flywheel will also be practically constant.

(To be continued.)

DYNAMOS FOR MOTOR ROAD VEHICLE LIGHTING.

By J. D. Morgan, Associate.*

During the past few years serious attention has been directed to the development of electric lighting systems for motor road vehicles, as it is widely recognised that something superior to the ordinary methods of oil and acetylene lighting is urgently needed. The principal conditions to be complied with are: (a) That the dynamo must be capable of maintaining a practically constant voltage over a wide range of speed variation and under different loads; and (b) if voltage variations are unavoidable, the amount of variation must not seriously affect the brightness of the lamps. Regarding the first condition, it is usual to arrange for the dynamo to supply current at the normal voltage when the vehicle is moving at the rate of from 10 to 15 m.p.h., and to maintain the voltage constant, or as nearly constant as possible, at all superior speeds, which may reach 50 to 60 m.p.h. When the vehicle is at rest or travelling below 10 m.p.h. the current is supplied entirely or for the greater part by a battery arranged in parallel with the dynamo circuit. Regarding the second condition, it is known that in metal filament lamps a small increase above the normal voltage is attended by a relatively large increase of brightness. In an experiment by Mr. G. A. Shakespeare at the Birmingham University an increase of from 8 to 8·8 volts in an 8 volt lamp caused an increase of candle-power from 14½ to 26.

A method of regulation which forms the basis of several known types of electrically regulated machines consists in the use of a separate counter-exciting dynamo adapted to diminish the excitation of the principal machine in such a manner that the field of the principal machine varies inversely as the speed. This device is obviously objectionable on account of the duplication involved. Several attempts have been made to construct machines in which a series compensating winding is used, the idea being to diminish the strength of the field progressively by the current in such winding after the normal voltage has been reached. Obviously a constant voltage cannot be obtained, but what is aimed at is to keep the voltage variation within practical limits over a given range of speed variation. A machine embodying this principle for road vehicle lighting is produced by Messrs. Bleriot, Ltd., in which the shunt winding is connected across the external circuit, and the current leaving the armature passes through the series winding before reaching the shunt winding. A centrifugal switch closes the external circuit when a certain speed is attained. Usually the arrangement is identical with that of an ordinary compound-wound dynamo, excepting that the series winding acts in opposition to the shunt winding. By the Bleriot method a much larger voltage variation can be produced at the brushes than is experienced in the external circuit, and the current through the shunt winding is subject to smaller fluctuations than it would be if connected across the brushes. Consequently a greater compensating effect can be obtained from the series winding than would otherwise be possible. Describing a representative result selected from a large number of tests made upon a Bleriot machine, the author said the machine was intended to supply lamps consuming about 12 amperes at 12 volts, but was designed to give out as much as 25 amperes. In the experiments the battery used was a set of six Fors cells of 50 ampere-hours capacity. Between the speeds of 1,600 to 4,000 r.p.m. the voltage rose from 10·5 to 13·75 and the current increased from 6 to 18. Over the same range of speed variation the voltage at the brushes rose from 11·5 to 16·75. A result of the test was a demonstration of the fact that the regulation of the machine is dependent on the condition of the battery. At the higher speeds the current given out is much larger than that consumed by the lamps, and in consequence a heavy surplus is directed into the battery. In one experiment the voltage in the external circuit increased from 15 to 20 without any alteration of speed, this being due apparently to change in the condition of the battery. Obviously to get the best results the current given out should approximate more closely to that required by the lamps, and this observation applies generally to all types of machines. It is sometimes urged as an advantage that certain machines are capable of giving current largely in excess of requirements. Apparently this is fallacious; it is a disadvantage rather than an advantage. The best results as regards steadiness of voltage are obtained when the maximum output does not exceed the consumption by more than about 2 or 3 amperes. With some batteries this figure may be increased, but in all cases a heavy charging current should be avoided. Under a smaller load the voltage variation in the external circuit proved greater than before and, in fact, was excessive.

An exceedingly good and interesting machine of the interbrush type is that of Messrs. Trier & Martin. The machine is of two-pole shunt wound construction, and is provided with a pair of intermediate brushes placed midway between the ordinary main brushes. The main and interbrushes are connected together through resistances. The makers describing the action of the machine in their patent specification say: "As the load increases, an armature reaction is set up which displaces the axis of the field forward and by so doing reduces the current in the resistances, and consequently the magnetic field is also reduced. When the axis of the magnetic field is displaced by 45°, there will be no current at all between the main and auxiliary brushes, as they will then be at equal potentials. A further displacement of the magnetic field due to increasing load and speed will cause a current to flow again between the main and auxiliary brushes, but such current will now be in the reverse direction and its effect will be to weaken the main field instead of to strengthen it. Thus the output of the dynamo becomes self-regulating."

Regarding the performance of the machine, the output rapidly rises until a speed of about 1,600 r.p.m. is reached. Above this speed the output rises very slowly and keeps within a practical limit. As with other self-regulating machines, a battery is essential, and the maximum voltage and current obtained depends to some extent on the condition of the battery. The variations with changes in lamp load are insignificant. In one experiment, cutting out all the lamps caused an increase of the maximum voltage of ½ volt and a diminution of current of less than ½ ampere. With lamps consuming 4½ amperes the maximum current given by the machine was 8 amperes.

Another interesting machine is the Midgley-Vandervell, or C.A.V. machine. In this machine, when the current in the short-circuited coils reaches a certain value, the magnetism associated with them appears to break down the principal flux at the parts adjacent to those coils, and causes the flux to swing into opposite quadrants. At this stage the machine becomes self-regulating, as the cross-magnetisation due to armature coils under the poles counteracts the principal flux and so progressively weakens the field as the speed increases. This action proceeds to a limit beyond which under a given load the voltage and current are constant at all speeds.

The behaviour of a machine in practice was shown by the author in a diagram representative of a large number of tests. This indicates that when the maximum voltage is reached it remains remarkably steady. A drop is shown in current at the higher speeds, due probably to defective brush contacts. The maximum current directed into the battery was 1·2 amperes. With such a small charging current a practically uniform condition is maintained in the battery, and the latter is therefore not so likely to interfere with the regulation of the machine as when a machine is used the output of which is largely in excess of the demand. The lamps used in the test were two 12-volt head lights in

* Abstract of a paper read before the Birmingham Local Section, Jan. 10, 1912.

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parallel and three 4-volt side and tail lights in series. Using the head lights only the maximum volts increased from 13 to 13·5, and using the side and tail lights only, the maximum volts rose to 14.

Referring to the inability of self-regulating machines to operate without a battery, the author said it would be observed that in each case a rapid increase of current and a comparatively slow increase of voltage is obtained during the slower speeds of the machines. Without this, self-regulation cannot be obtained, for it is upon the production of a large increase of current with a comparatively small increase of voltage that the machines depend for their action. It follows, therefore, that if the required variations of current with changes of potential cannot be obtained, the machines lose their characteristic.

Describing the Grob system, the author pointed out that with increase of voltage across the brushes the difference of potential at the ends of the windings diminishes, and in consequence the strength of the field diminishes. This action rapidly proceeds to a limit above which the voltage and output of the machine under a given load remains fairly constant at all speeds. The system appears to be capable of giving good results, but it possesses the serious disadvantage that a battery of twice the normal size must be carried in order that one-half may be charged whilst the other half is in service, whilst the permanent or residual magnetism of the machine seems to prevent a perfectly steady voltage from being obtained.

Describing mechanically regulated dynamos, the author observed that the most important of mechanical devices hitherto produced for regulation purposes are those depending upon a slipping drive. These are divisible into two classes, which are characterised respectively by constant torque and constant speed. Engineers have long been familiar with a notable instance of constant torque in the Stone machines, which employ a slipping belt. In view of the extensive use and excellent service of these for railway-train lighting, it is natural to consider whether they are equally applicable to motor-car lighting. Apparently they are not. In the first place, it is generally expected that as soon as electric lighting on motor vehicles becomes extensively adopted, provision will be made by builders for direct connection of the dynamo to the engine, as for the magneto. This would at once make the use of a belt inconvenient, if not impracticable. In the second place, a constant torque device is wrong in principle for motor-car lighting. No doubt tolerably good results could be obtained, but development could never reach perfection on account of the inherent unsuitability of the device for this particular service. The problem before the designer is to keep the voltage at the lamps as constant as possible. Assuming that a constant torque mechanism is adjusted to slip under full load at a given speed, then if the load be reduced considerably, the speed of the dynamo will at once increase, and this will result in increase of voltage, which, although it may be prevented by a suitably proportioned battery from becoming excessive, can never be avoided.

As regards constant speed devices, these usually consist of a governor-controlled clutch. An exceedingly good form is one constructed by Messrs. Joseph Lucas, Ltd., in which a driving pulley is arranged to run freely on the armature shaft and is shaped at one end to contain a number of free governor balls. The latter are supported in slots in a plate keyed to the armature shaft, and are arranged to bear against the inner surface of a clutch element which whilst secured to the shaft can slide thereon. The inner periphery of the pulley is shaped to correspond with the outer periphery, and between the two surfaces is inserted a thin ring of vulcanised fibre. Springs serve to keep the clutch in action. At and below a certain speed the mechanism revolves as one piece, but above that speed the balls, by their centrifugal action, relieve the pressure due to the springs between the clutch surfaces and enable slipping to occur. There is no appreciable separation of the clutch surfaces when in action, but simply a variation of pressure. The balls are connected to the driven part and not the driving part of the mechanism.

As might be expected, a jerkiness of action is a common fault in slipping clutches at the critical speed owing to the difference between static and kinetic friction, and a drop in speed is often experienced at the instant when slipping begins; or, in other words, the clutch can continue to accelerate the speed of the armature beyond the maximum speed for which the clutch is adjusted, but as soon as slipping sets in the speed drops and remains tolerably constant at all superior speeds of the driving pulley. Messrs. Lucas have avoided this defect by arranging for ample lubrication of the clutch surfaces so that they are always separated by a thin film of oil. By this provision the instant at which slipping occurs becomes practically imperceptible, and an extremely smooth action is obtained.

As with other machines, the Lucas dynamo is arranged to work in conjunction with a battery, supplying into the latter about 2 amperes when the maximum output is reached. When the clutch is adjusted to suit the particular lamps and battery which it is required to supply, the cutting out of the battery involves a large (though restricted) increase of voltage in the lamp circuits. This is, however, not so serious as in the electrically regulated systems described, and would not render it impossible to use the lights in the event of a mishap to the battery.

THE DEVELOPMENT OF THE CIRCLE DIAGRAM FOR THE THREE-PHASE INDUCTION MOTOR.

In the course of the discussion which followed the reading of Mr. T. F. Wall's paper on "The Development of the Circle Diagram for the Three-Phase Induction Motor," before the Birmingham Local Section

Mr. L. H. A. Carr pointed out that fig. 6 was practically the same as the standard approximate diagram given by Arnold and others, but that Arnold had carried the construction further and obtained a slip line in a more convenient position, *i.e.*, with the scale nearer the circumference of the circle at the working value of the current. He then pointed out that to obtain fig. 5 the author made three assumptions, viz.: (1) Stator flux constant (negligible stator resistance); (2) iron losses constant; (3) I^2R loss due to magnetising component of current negligible. While the second of these was approximately true, the other two assumptions were not justified in practice if it was desired to obtain a true diagram of the performance of the machine particularly if it was a small machine and had large (comparative) losses or had many poles, and hence high magnetising current. It was preferable to consider not the iron losses as constant but the iron and friction for then when the circle was constructed the friction torque at standstill was not indicated as useful torque on the diagram (as in the author's figure). When stator resistance was taken into account the centre of the circle became shifted upwards away from the x axis. This could be shown by drawing a circle for constant back e.m.f. (constant flux) and then adding a portion Ir for the stator resistance to obtain the total terminal volts. The current vector could then be reduced in the proportion of the two voltages and turned through the necessary angle to reduce it to constant terminal voltage. If this were done for a series of points on the circle, the new constant voltage circle would be seen to be raised above the old constant flux circle. This was shown more fully and proved by Arnold and La Cour in their book on the induction motor. Their practical rule for finding the centre was for stator and rotor equivalent resistances nearly equal, to erect a perpendicular on the running light point and to bisect the intercept between this point and the short-circuit current line. The centre would lie on an abscissa through this bisection point. Test results over a wide range of motors, down to fan motors of fractional horse-power, showed close agreement with the circle obtained by this method. Not only because of the running light I^2R loss, but also since the horizontal diameter did not pass through the running light point, the "straight line" method of obtaining the b.h.p. and torque lines did not give correct results, but the true lines of stator and rotor copper loss had to be calculated. This was quite easy, as the short-circuit losses being split up by marking off the stator copper losses (which were capable of fairly accurate determination), it was a simple slide-rule calculation to obtain the scale distance representing the loss proportional to the square of any given current line on the diagram. The figure showed from an actual test the shape these lines would assume. Consideration would show that in the case the author had considered the facts that there was not a wide

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divergence between the no-load and short-circuit power-factors, and that the magnetising was relatively small, tended to bring the centre of the true circle comparatively close to the author's approximations and hence the agreement with his test results. However, to be of any practical utility the circle diagram must be constructed so as to correctly represent the case of every motor. A theory could not be assumed to be proved because figures obtained by its use agreed with practice in one particular case.

Dr. S. P. SMITH said Mr. Wall was to be congratulated on his novel suggestion for developing the circle diagram for the induction motor by means of the rotating field. Unfortunately, he (Dr. Smith) had not been able to follow the argument, however, in the author's convention for the representation of the vector of this field. Thus on page 1 it was stated "the vector of the rotating field will be drawn to coincide with the E.M.F. which it induces." But how could this be possible when the induced E.M.F. depends on the rate of variation of the field? Again, on page 3 it was stated "the rotor current must be in phase with the actually existing rotor flux cutting the rotor winding." Surely this statement was liable to misinterpretation for the rotor current was practically in phase with the induced pressure under normal conditions whilst the pressure naturally lagged 90° behind the flux inducing it. Similarly in Fig. 1, unless this was intended to represent M.M.F.'s, it should be regarded as a fictitious flux diagram except at no-load, when the conditions for the stator would be somewhat as shown. Of course, if the fictitious flux diagram for the stator was added to a corresponding fictitious flux diagram for the rotor, the actual flux diagram for the machine would be obtained as the resultant. The diagram deduced by the author differed very little from that developed by Ossana and used largely by Arnold as the no-load and short-circuit diagram. The use of circle diagrams for induction motors should not be over-estimated. Owing to the magnitude of pulsation losses and other uncertain quantities, the simple Heyland diagram was sufficiently accurate for small motors. For larger motors above 50 h.p. a more accurate form might well be adopted, and close agreement between test results and calculation could be expected. In such diagrams it was of the highest importance that the scales should be made quite clear both in the description and the application.

Mr. G. SHEARING, in a communicated comment, said the vector diagram given by Mr. Wall differs considerably from those of other writers on the same subject. He has utilised the vector of a rotating field, as represented by the flux cutting the conductors of one phase, to deduce the diagram. This gives a phase displacement of 90° with respect to time for the rotating field and the current producing the field. It is due to this representation of the rotating field that the rotor current and the actually existing rotor flux are in phase with respect to time. That they are in phase is hardly clear from the paper. The following considerations may help to explain this. The actually existing rotor flux may be regarded as due to the vector combination of part of the stator rotating field and the rotor rotating field. The stator rotating field induces an E.M.F. in the rotor in phase. The rotor current lags with respect to this E.M.F. and sets up the rotor rotating field which lags with respect to the rotor current by 90°. Combining these hypothetical stator and rotor rotating fields, we get the actual rotor field. The maximum value of this flux will be cutting a given rotor conductor at practically the same instant as that for which the current in that conductor is a maximum. Thus according to the author's convention they are in phase. The vector diagram is purely a time diagram in its phase relations. The circle diagram is obtained in a simple manner, and the above application of the rotating field vector seems to be new.

Mr. T. F. WALL, replying to the points raised, said: With reference to the remarks of Mr. L. H. A. Carr as to the assumptions made in producing the diagram, he would call attention to the last two paragraphs of the paper. It is stated there that the error due to the assumptions made is less than would appear at first sight owing to the fact that the circle diagram is drawn through the two actual test points. As an old student of Prof. E. Arnold, he fully appreciated the methods employed by him and his collaborators in developing the circle diagram for the induction motor. At the same time it could not be denied that Prof. Arnold's methods were not easily understood. As far as the circle was concerned, there were two points which must be the same for both methods, viz.: the experimentally obtained no-load and short-circuit points, the difference lying in a slight displacement of the centre of the circle. The motor referred to in the paper was an 8 b.h.p. 6-pole one and was used because it was the first available. Prof. Arnold's approximate construction referred to by Mr. Carr would be found to give a circle practically coincident with that of Fig. 6 of the paper. There was, however, another point, and that was the influence of saturation of the magnetic circuit. Prof. Arnold assumed that the iron had constant permeability and modern motors were certainly not worked below the saturation point. It was then hardly logical to insist on extreme accuracy in one direction if there was considerable error in another. If Mr. Carr was not satisfied that the test figures given were not sufficient evidence of the accuracy of the circle diagram, Mr. Wall would like to see curves deduced similar to that of Fig. 7, and thus ascertain what discrepancy might be expected in those cases which Mr. Carr considered to be doubtful.

Referring to Dr. Smith's remarks, it was surprising that the statement contained in his first quotation was not obvious. If a conductor was cut by a steady and uniformly rotating field the E.M.F. induced in that conductor was at every instant proportional to the field cutting the field at that instant. The reason Mr. Wall had chosen the E.M.F. to represent the flux vector instead of dealing with the field itself, was because the E.M.F. induced by the rotating field takes the direction of rotation of the field into account. This method of representing the rotating field seems to me to be a perfectly natural one. A full appreciation of these points should clear away the difficulty found in understanding the second quotation. The reference to Fig. 1 seemed to show that Dr. Smith was not very familiar with the superposition method of dealing with magnetic problems. Mr. Wall stated that Fig. 1 showed diagramatically the rotating field which would be established by a three-phase current in the stator winding if the rotor winding were carrying no current. With regard to the scales of the diagram, it should be noted that in Fig. 4 BV represented the watt component of the current per phase corresponding to the developed h.p., i.e., the applied volts per phase × current BV × number of phases ÷ 746 gives the h.p. which BV represents. Again, BW represented the watt component of the current per phase corresponding to the power transferred to the motor, i.e., the applied volts per phase × current BW × number of phases = torque × synchronous speed in radians. The torque obtained from this relation was represented by the line BW.

AN AUTOMATIC STARTING DEVICE FOR ASYNCHRONOUS MOTORS.

In the discussion on the paper by Mr. Pensabene-Perez on "An Automatic Starting Device for Asynchronous Motors," which was also read before the Birmingham Local Section

Mr. A. LINDSAY FORSTER remarked that on page 7 the author referred to certain difficulties which had to be overcome in the development of the details, which suggested to him that the author might have had some trouble arising out of the effect of the inertia of the moving parts. In designing steam engine governors in which the operating weights on axes parallel to the rotating shaft, it was necessary to consider the effect of any change in the rate of motion because such change affected the equilibrium established between the centrifugal force of the weights and the spring which opposed it. In the diagram, Fig. 1, if a line was drawn from the shaft centre through the centre of gravity of the weight in any position and another line normal to it also passing through the same point would be the one along which inertia and momentum would act in their respective directions during any change in the rate of motion. If this line did not pass through A, the fulcrum and then the weight itself would be affected by such changes, but in any other position the effect of these changes would be directly proportional to the distance of the line from the fulcrum A. In the diagram the weights while at

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their inmost position would be unaffected by these forces, but as they moved outwards the influence of any increase in the speed of the motor would oppose the centrifugal force, whereas a reduction in speed while the change was in progress would assist the centrifugal force. Similar reasoning applied to all the moving masses in the governor system. In Fig. 1, for example, the weight of the brush arm while centrifugally opposed to that of the governor weight acted in unison with it with regard to inertia and momentum. If the direction of rotation was reversed the above effects would be reversed, and it would be interesting to know whether the author found that with a reversible moter he noticed a difference between the performances in the two directions. When starting a machine which offered a constant torque these effects would not be of as much importance as they might be where the torque was variable, under which conditions the rate of acceleration would also be variable. Mr. Lindsay Forster noticed that the author in his very interesting paper had dealt very thoroughly with other matters of design, but he did not see any reference to the above effects, and it occurred to him that they were possibly worth consideration and might interest the meeting.

Dr. C. C. GARRARD remarked that the author was to be congratulated on his very ingenious invention, which should find many useful applications, especially where three-phase motors were to be started by totally unskilled people or by people who knew nothing about electricity, such as would be the case when motors were installed for isolated machinery. Dr. Garrard did not think the apparatus would supersede the ordinary starter in large works, where the motors were usually started by a skilled person, and he also doubted whether the apparatus was cheaper than slip-rings and a rotor starter. He thought the author had limited the usefulness of the paper by an unnecessarily mathematical treatment. No doubt the author found the mathematical investigation of use in that it is limited in this case in its application is admitted on page 5: "the analytical solution leads to complicated expressions of difficult application"; and then the author proceeded to use a graphical method. Moreover, a long mathematical proof was not needed to demonstrate that the ratio between spring tension and static friction must be as large as possible, or all these troubles have practically eliminated by reducing the friction as much as possible, as stated on pages 7 and 8. In order to achieve success in any electro-mechanical appliance from an ammeter upwards it was necessary to keep the working forces large in comparison with the friction. Dr. Garrard wished to ask the author how his device worked if the conditions were different from those assumed when calculating the resistance slope of gearing, etc. With the ordinary scheme of self-starting and automatic accelerating control gear means were provided by the use of a relay or other device that the speed of starting, time taken to cut out the various steps of resistance adapt themselves to the conditions of starting. With the author's device a certain speed corresponded to a fixed position of the centrifugal arrangement, which put a fixed resistance in the rotor circuit independently of the torque required to drive the load at that speed. It seemed to him that if the starting conditions were very different from those allowed for in the design complication might arise, and he would be very glad if the author would enlighten him on that point.

Mr. N. PENSABENE-PEREZ, replying, said he felt very much olbiged to Mr. Lindsay-Forster for calling attention to the action of inertia of the moving parts as affecting the equilibrium of the system, when sudden variation of speed took place. In actual practice these variations (owing to the inertia of the meter itself and the machinery driven by it) are too slow and the stored energy of the moving weight too small, to appreciably notice any of the effect mentioned by Mr. Forster. He had recently tried the case of a self-starting motor driving a dynamo fully excited on which the current was suddenly varied while starting, but no special fluctuation of the motor starting current was observed owing to this sudden change of load torque. This was found so when running in either direction. It must be noted that with the exception of the moving weight, all the weight of the arms, gear, etc., are balanced, and this explains partly why the phenomena mentioned by Mr. Forster are not noticeable in practice.

With reference to Dr. Garrard's remarks, the author could not agree with him that in larger motors handled by skilled persons the usual slip-ring motor and starter could not be superseded by the self-starting motor. It was, of course, only responsibility and cheapness which in time would decide this point, and from either of these points o view the balance was in favour of the automatic self-starting motor. Dr. Garrard's reference to the use of mathematics in the paper, gave the author a strong suspicion that he was under a misapprehension on this point. If Dr. Garrard was kind enough to read the paper again he would notice that no unnecessary mathematics were used and that all the formulæ arrived at were necessary for the graphical solution given in the paper. Dr. Garrard seemed to think that the "analytical solution which leads to complicated expression of difficult application" has been developed in this paper, while this was not the case, Formula 2 being only the differential equation which had to be solved. This was done only by a graphical method. Moreover, no long mathematical formula was given to prove that the ratio between spring and static friction must be as large as possible. The simple formula given gave the value of the increase in speed necessary to overcome the difference between static and dynamic friction. With reference to remarks of Dr. Garrard as to adaptability of the self-starting motor to the different conditions of starting, the author remarked that in cases where the load torque expected was smaller than the actual torque to deal with, the apparatus described could be easily adjusted by a simple arrangement which would prevent the contacts going all the way back under the action of the spring. By this arrangement only a fraction of the resistance was used for starting, and thus a larger starting torque was obtained. This the author thought would answer satisfactorily for ordinary practical requirements.

The Birmingham Local Section and the New Constitution.

As there seems to have been some misapprehension as to what happened at the special meeting of Members, Associate Members and Associates held at Birmingham to discuss the proposed amendment to the constitution, we are asked to publish the subjoined copy of the resolutions passed at that meeting. These were as follows:

"(1). Proposed that proposed new article 12, subsection D, should be deleted and that subsection D of article 12 of existing articles should be substituted.

"(2). Proposed that article 14 should read as follows:—'Every candidate for election or transfer to the class of Associates shall be a person of good education who, ALTHOUGH NOT ELIGIBLE AS A MEMBER OR ASSOCIATE MEMBER is in the opinion of the Council connected with the applications of electricity that his admission as an Associate would in the opinion of the Council conduce to the interests of the Institution. (Change indicated by capital letters.)'

"(3). Proposed that new article 15 and all reference to Licentiates should be deleted.

"(4). Proposed that new article 15 should read as follows:—'Subscriptions be not raised to existing members of any class and that subscriptions of new members of any class joining after July 1, 1912, or transferring after July 1, 1913, be according to the new schedule as far as London members are concerned and at the old rate for members living more than 20 miles from the Institution buildings.'

"(5). Proposed that in new articles 66 and 69 the clause subject to the sanction of two Extraordinary General meetings be inserted.

"(6). Proposed that the final decision of the Institution should be taken by a postal vote of corporate members in the British Isles on the leading points in the proposed new articles of association to which exception has been taken."

NEWCASTLE STUDENTS' SECTION.

Much enthusiasm is being manifested on Tyneside in the formation of a strong Students Section of the I.E.E. The first ordinary meeting was held on Monday, January 8, and Mr. M. Shuttleworth had the distinction of being elected the first chairman, and Mr. B. A. Robinson, the

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vice-chairman. Mr. W. A. Hatch, of 27, Eversley-place, Heaton, Newcastle-upon-Tyne, accepted office as honorary secretary.

Mr. Vesey-Brown, President of the Local Section, opened the proceedings with a short address of encouragement, and a paper by Mr. B. A. M. Cooper, on "The Localization of Faults on Low Tension and High Tension Cables," was read and discussed.

There seems every promise of the Students Section progressing favourably. There are already over 100 Students in the Section and it is expected that this figure will soon be doubled.

MUNICIPAL ELECTRICITY.

For the first time in the history of the local authorities of England and Wales, the Local Government Board has this year made a valiant effort to bring municipal statistics up to date. As a result there has been issued this week a Parliamentary White-paper giving details of the receipts, expenditure, and outstanding loans of these authorities up to the end of March of last year. The return contains much interesting material, especially in relation to municipal electricity undertakings. At the outset we learn that during the year under report the total of the sums transferred in aid of rates from the accounts of electricity and gas supply undertakings, harbours, docks, piers, canals and quays, tramways, light railways, and waterworks, was £1,320,000, including £1,203,000 transferred by town councils. The total of the sums transferred from rates to meet deficiencies in the accounts of such undertakings was £971,000, including £631,000 transferred by town councils. Coming to electricity finance pure and simple, we find these local authorities credited with having received during the year £4,078,000 from private consumers and £1,347,000 for public lighting, a total of £5,425,000. Their expenditure was £4,967,000 and their payments to reserve and other funds totalled £245,000, an aggregate of £5,212,000. The authorities working at a profit transferred £192,000 of surplus revenue in aid of rates, and those in a less fortunate position borrowed from the rates £66,000 to meet deficiencies in their revenue, leaving a net profit balance over the grand aggregate of trading of £126,000. On gas account local authorities received from private consumers £7,794,000, and from public lighting £557,000, a total of £8,351,000, and their expenditure was £7,686,000, which included £197,000 for payments to reserve and other funds. The profit making gas undertakings transferred in aid of rates £560,000 and the non-profit making enterprises had to borrow £7,000. The outstanding loans of the electrical undertakings stood at £29,542,000 and of the gas undertakings at £22,442,000. The revenue from tramways and light railways was £8,992,000 and the expenditure £8,862,000, including £633,000 to reserve and depreciation, and the successful undertakings allocated £387,000 in aid of rates, while the less successful borrowed from the same source £128,000, the net profit balance being thus £259,000. The outstanding loans aggregated £36,216,000. The total outstanding loan debt on all accounts reached the colossal figure of £410,695,000, towards the payment of which there remained in sinking funds on March 31 the sum of £21,198,500. Their total receipts from all sources other than loans were £122,953,000.

LONDON ELECTRICAL ENGINEERS.—Officer commanding, Lieut.-Col. H. M. Leaf. Orders for week ending January 20:—Monday, January 15.—"A" Company: Technical work, musketry instruction (Standard tests), 7 to 10 p.m. Tuesday, January 16.—"B" Company: Technical work, musketry instruction (Standard tests), 7 to 10 p.m. Thursday, January 18.—"C" Company: Technical work, musketry instruction (Standard tests), lecture by Major Phillips, 7 to 10 p.m. Friday, January 19.—"D" Company: Technical work, musketry instruction (Standard tests), lecture by Major Phillips, 7 to 10 p.m. Saturday, January 20.—Headquarters will be opened for Regimental business from 10 a.m. to 12 noon.—(Signed) J. H. S. PHILLIPS, Major, for Officer Commanding London Electrical Engineers.

The "Synchron" Apparatus.

The "Synchron" Life-Saving Apparatus for the Promotion of Artificial Respiration in cases of Electric Shock, Drowning, Mine Gas Poisoning, etc., is now being manufactured for us in London and Birmingham under expert personal supervision, and all orders are being filled in rotation as speedily as we can obtain supplies of castings.

Sets of apparatus have already been ordered for the following Power Stations:

LONDON.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LTD.
BROMPTON AND KENSINGTON ELECTRIC SUPPLY COMPANY, LTD.
WEST HAM BOROUGH COUNCIL ELECTRICITY DEPT.
POPLAR BOROUGH COUNCIL ELECTRICITY DEPT.
NORTH METROPOLITAN ELECTRIC POWER SUPPLY COMPANY, LTD.
ST. PANCRAS BOROUGH COUNCIL ELECTRICITY DEPT.
THE CHARING CROSS, WEST END AND CITY ELECTRICITY COMPANY, LTD.
THE METROPOLITAN ELECTRIC SUPPLY COMPANY, LTD.
LONDON ELECTRIC SUPPLY CORPORATION, LTD.
STEPNEY BOROUGH COUNCIL ELECTRICITY DEPT.
ISLINGTON BOROUGH COUNCIL ELECTRICITY DEPT.
SOUTH METROPOLITAN ELECTRIC TRAMWAY AND LIGHTING COMPANY, LTD.
CROYDON COUNTY BOROUGH ELECTRICITY WORKS.

COUNTRY.

GLASGOW CORPORATION ELECTRICITY DEPT.
CLYDE VALLEY ELECTRIC POWER COMPANY, LTD.
MANCHESTER CORPORATION ELECTRICITY DEPT.
LANCASHIRE DYNAMO AND MOTOR COMPANY, LTD.
THE BRITISH THOMSON-HOUSTON COMPANY, LTD.
AYR CORPORATION ELECTRICITY WORKS.
MESSRS. HARLAND & WOLFF, LTD., Belfast.

ABROAD.

MESSRS. ANDREW MOIR & COMPANY (for South Africa).
MESSRS. STRACHAN OSWELL & COMPANY (for South Africa).
THE BAKHTIARI OIL COMPANY, LTD.
THE ANGLO-PERSIAN OIL COMPANY, LTD.

OTHER ORDERS.

VICTORIA FALLS AND TRANSVAAL POWER COMPANY, LTD. (12 machines).
THE MERSEY DOCKS AND HARBOUR BOARD.
THE MANCHESTER SHIP CANAL.
MESSRS. H. SIMONIS & COMPANY, Fire Engineers.
MESSRS. HENRY MORGAN & COMPANY.

TENDERS, ETC.

BUENOS AYRES AND PACIFIC RAILWAY COMPANY, LTD. (12 machines).

Many of the orders referred to are for 6 and 12 machines and upwards.

Inquiries should be addressed to the Manager of the ELECTRICAL ENGINEER, 149, Fleet Street, E.C., by whom illustrated descriptive pamphlets will be sent post free on application.

BUSINESS NOTES.

Messrs. Hans Renold, Ltd., inform us that for the purpose of getting into closer touch with their friends in Scotland, they have now opened an office in Glasgow at 86, St. Vincent-street (telephone 2454 Central), and have appointed Mr. F. M. Lawson, Assoc.M.Inst.C.E., A.M.I.Mech.E., as resident engineer for Scotland. Mr. Lawson has for some time held a leading position with the firm, and previously had a very extensive experience in various branches of mechanical engineering, so that he is fully qualified to advise on chain driving. For the present the Glasgow office will deal more particularly with matters requiring personal attention, but when enquiries are urgent, they may be sent there, although all correspondence relating to orders should still be addressed to Manchester. The Glasgow office will generally only concern itself with engineering matters, and not with cycle, motor and mortise chains.

Messrs. SIEMENS BROTHERS DYNAMO WORKS, LTD., inform us that owing to the continued increase of their business in all classes of supplies, they have again had to extend their premises at 39, Upper Thames-street. Extra space was taken about a year ago in the adjoining building—38, Upper Thames-street—to enable them to carry a larger stock of "Tantalum" and "Onewatt" lamps, but this has already proved insufficient. Their accommodation for stock is now more than double what was available in 1910, the new floors being chiefly occupied by "Zed" cartridge fuses, "Zed" distribution boards, arc lamp carbons, and accessories.

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Technical Problems and their Solution.

QUESTIONS AND ANSWERS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways, and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for the next best, but in the case of two replies adjudged to be of equal merit, these two sums may be added together and divided. Replies should reach the office within seven days of the appearance of the questions.

QUESTIONS.

Problem No. 1269.—It is required to measure insulation resistances varying from one megohm to 50,000 megohms, using a galvanometer of 150 ~ sensitivity and 800 ohms resistance. State, with reasons for preference, which of three universal shunts having a total resistance of 100,000, 10,000, and 1,000 ohms respectively, would be most suitable for use with this galvanometer for obtaining the required measurements. "BICKNOLLER."

Problem No. 1270.—When using a universal shunt in conjunction with a galvanometer it is best to have the total resistance of the universal shunt not greatly differing from that of the galvanometer, for if the resistances of galvanometer and shunt are disproportionate a loss of sensitiveness occurs. Explain the reason for this.—"BICKNOLLER."

Problem No. 1271.—Explain—with theoretical justification—a method of measuring fault resistances, applicable to 3-phase or 2-phase 3-wire networks. Simplicity is important.—"QUERIST."

Problem No. 1272.—On a three-phase circuit of shaft cables there are two pumps; one a turbine the other a three-throw. Starting up the three-throw causes a wattmeter coupled to one phase (balanced load) to revolve in its correct direction. Starting the turbine one now causes the disc to slow down, stop, and revolve in the opposite direction. Turbine works at half normal head. Pressure coil of wattmeter is connected to a potential transformer phase to neutral.—"P. F."

ANSWERS.

Problem No. 1268.—A three-phase 50 ~ 500 volt, 25 h.p. motor with wound rotor is connected up to 400 volt 50 ~ mains. Full load r.p.m. on 500 volts = 1,450. On 400 volts the maximum full load speed was 1,360 r.p.m. The rotor winding and slip rings got very hot. On short-circuiting the slip rings (carbon brushes, no short-circuiting device) with a copper bar the speed became 1,420 r.p.m. Now, an exactly similar squirrel-cage motor ran at 1,450 r.p.m., although on 400 volts instead of 500. Will someone explain the reason of the unusually large slip of the first motor?—"ROTOR."

As this question has given rise to some interesting points we give two further replies.

Answer to No. 1268 (*awarded* 5*s.*).—In any motor the torque, or turning effort, causing rotation of the rotor, depends directly upon the product of current in the rotor windings and the field strength. If one factor is reduced the other must be increased to enable a motor to give its rated output.

Consider the machine having a wound rotor; this machine though intended for 500 volts is put on mains having a potential difference of 400. Speaking roughly, owing to decreased strength of field the current in rotor conductors must be increased in the ratio of 5 : 4. Therefore, the increase in current necessary for the motor to perform its work results in the rise in temperature of winding and slip-rings noticed by "Rotor." That the full load speed when energised from 400 volt mains should drop

$$1450 - 1360 = 90 \text{ r.p.m.}$$

is quite natural. The current in the rotor conductors is due to the electromotive force they generate; this electromotive force depends upon the "slip." For increased current there must, therefore, be a higher electromotive force generated, which means that the rate of cutting the magnetic lines of the field by the rotor conductors must be greater, consequently there must be more slip. It must be remembered that if there were no slip, field of stator and the rotor would move in synchronism and the electromotive force generated would be zero. The electromotive force generated by the rotor conductors and therefore the current in them depends directly on the slip. Although the periodicity is the same at 400 as at 500 volts, with 400 volts the field will be weaker; thus there are two reasons why the motor should run slower. First, a greater current is required in the rotor conductors, and, secondly, these conductors are in a weaker field. The greater current must be obtained from the weaker field, thus the increase in slip which results in the decreased number of revolutions per minute. That short-circuiting the slip ring brings the speed up to 1,420 r.p.m. is simply due to the reduction in resistance of the rotor circuits. The current in rotor conductors is the result of electromotive force generated in those conductors; if a resistance is inserted in the rotor circuit a certain proportion of the generated voltage is lost, such loss being represented by (resistance added) × current in rotor. When such added resistance is cut out, as is done by the querist when he short-circuits the slip rings, there will only be sufficient volts required to force the necessary current through the rotor windings. Therefore, the slip will be reduced and revolutions of the rotor per minute increased. In the query this rise is from 1,360—1,420. The above is only intended as a simple explanation; to be more precise, account should be taken of the increased current through the stator when connected to 400 volt mains in place of the normal 500.

With regard to the squirrel-cage motor there is not sufficient data given for a definite explanation; a squirrel-cage motor can scarcely be exactly similar to a machine having a wound rotor. Squirrel-cage windings may have such a low resistance that the slip is reduced to a very small percentage, and, therefore, very little difference in the number of revolutions per minute be noted when the machine mentioned is placed on 400 volt mains; but no doubt a careful test will give a somewhat different complexion to the state of affairs. Within the limits of the motor little difference may be observed to what might be expected; such limits are largely governed by the resistance of the windings.—"M. M."

Answer to No. 1268 (*awarded* 5*s.*).—It is hardly necessary to state that for a given load, if the voltage of a motor be reduced, the power component of the current in the stator and rotor will be increased, so that the power developed may be the same. It is quite clear then that if the rotor current has to be increased, an increase in rotor voltage will be necessary to drive this current through the resistance of the rotor winding. As the voltage has been reduced to 400 volts, the back E.M.F. in the stator need be only 400, instead of 500, comparatively speaking; therefore the magnetic flux will be reduced approximately in the same proportion. The value of the increased rotor voltage, clearly, depends the slip and the magnitude of the magnetic flux; but since, as stated above, the flux is reduced, the slip must, therefore, be considerable. It is stated, that on short-circuiting slip-rings with a copper bar, the speed became 1,420 r.p.m. This increase in speed is due simply to the resistance of the rotor circuit being decreased, the resistance cut out being leads, contacts, and very likely some resistance still left in circuit. In comparing the behaviour of this motor with a similar one of the squirrel-cage type, the characteristic curves of the

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two machines would be very desirable. It is well known that for every induction-motor there is a certain load on which the power-factor of the motor will be a maximum, at what load this shall occur for each individual motor is a question settled by the designer and depends under what conditions the machine is going to run. About three-quarter full load is the usual figure, sometimes full load; as mentioned above, these values simply depend on conditions of loading. It is highly probable that the maximum power-factor occurs on quite different loads for the machines under comparison. From details furnished, it would seem that the squirrel-cage machine is running under better conditions at 400 volts, as regards power factor, than at 500 volts, there being less wattless current in the rotor, comparatively, than formerly, as the speed has not altered. As magnetic leakage furnishes wattless current, it would appear that this magnetic leakage has been reduced in the case of the squirrel-cage machine, and very likely increased in the case of the wound-rotor machine. Magnetic leakage is always more effective in producing wattless current in wound machines than in squirrel-cage machines, owing to the greater number of rotor conductors in series, the rotor conductors in series in the squirrel-cage being only 2. From what has been said above, the wound-rotor machine may be working under a very much worse power-factor at 400 volts, so that, not only is the power component of the rotor current increased, but the wattless component may be increased in a very much greater proportion. Although the wattless current furnishes no effect in transmitting power to the shaft, it nevertheless causes the rotor to heat up.—E. ADAMSON.

Correspondence.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

THE ASSOCIATION OF CONSULTING ENGINEERS.

To the Editor of the ELECTRICAL ENGINEER.

Sir,—As announced some time ago in your columns, a meeting of practising consulting engineers representing all branches of the profession will be held on Monday, January 15, at 4 p.m., in the Lecture Theatre of the Institution of Electrical Engineers, Victoria-embankment, W.C.

For the purpose of forming an Association of Consulting Engineers a code of rules has been drawn up which it is believed will be in the best interests both of the public and of the profession, and it is hoped that all eligible consulting engineers who are able will attend the meeting in order that the subject may receive the fullest possible discussion.

It is inevitable that the rules will require alteration and improvements as experience may dictate, but it is felt that they form a basis on which consulting engineers may associate together in the best interests of the profession.

In the absence at present of any recognised list, it is obviously impossible to communicate individually with every eligible consulting engineer, and it is hoped that all such will accept this invitation to attend the meeting, on presentation of their card at the entrance.

As it is sure to occur that a number of those who are in full sympathy with the aims and objects of the Association will find themselves unable to be present at the meeting, it is hoped that they will assist by sending their views in writing to the honorary secretary, Mr. A. H. Dykes, 11, Victoria-street, Westminster, S.W., from whom copies of the rules and other information may be obtained.

We are, dear sir,

Yours truly,

JOHN SYDNEY ALFORD, M.Inst.C.E., 9, Victoria-street, Westminster, S.W.

HENRY PERCY BOULNOIS, M.Inst.C.E., F.R.San.Inst., Past Pres. Inst. M. & C.E., Past Pres. L.Eng.Soc., M. Advisory Com. Road Board, 7, Victoria-street, Westminster, S.W.

WILLIAM TREGARTEN DOUGLAS, M.Inst.C.E., 15, Victoria-street, Westminster, S.W.

EDWARD MITCHELL EATON, M.Inst.C.E., 7, Victoria-street, Westminster, S.W.

ROBERT HAMMOND, M.Inst.C.E., M.I.E.E., M.I.Mech.E., 64, Victoria-street, Westminster, S.W.

JOSEPH H. HARRISON, M.Inst.C.E., M.I.Mech.E., M. Iron and Steel I., Past Pres. Cleveland Inst. E., 2, Exchange-place, Middlesbrough.

BALDWIN LATHAM, M.Inst.C.E., Parliament Mansions, Victoria-street, S.W.

CHARLES LOMAX, Assoc.M.Inst.C.E., 37, Cross-street, Manchester.

SIDNEY RICHARD LOWCOCK, M.Inst.C.E., 50, Queen Anne's-gate, Westminster, S.W.

ERNEST LAWSON MANSERGH, M.Inst.C.E., 5, Victoria-street, Westminster, S.W.

ARTHUR J. MARTIN, M.Inst.C.E., F.R.San.I., F.G.S., Pres. San. Inst., Eng., 7, Victoria-street, Westminster, S.W.

THOMAS LODWICK MILLER, M.Inst.C.E., 709, Tower-buildings, Water-street, Liverpool.

WILLIAM MORRIS MORDEY, M.Inst.C.E., M.I.E.E., Past Pres. I.E.E., 82, Victoria-street, Westminster, S.W.

WILLIAM HENRY PATCHELL, M.Inst.C.E., M.I.E.E., M.I.Mech.E., Caxton House, Westminster, S.W.

WILLIAM LLEWELLYN PREECE, M.Inst.C.E., M.I.E.E., 8, Queen Anne's-gate, Westminster, S.W.

HENRY ROFE, M.Inst.C.E., 8, Victoria-street, Westminster, S.W.

JOHN FRANCIS CLEVERTON SNELL, M.Inst.C.E., M.I.E.E., M.I.Mech.E., 8, Queen Anne's-gate, Westminster, S.W.

EDMUND HERBERT STEVENSON, M.Inst.C.E., 38, Parliament-street, Westminster, S.W.

JAMES SWINBURNE, F.R.S., M.Inst.C.E., M.I.E.E., Past Pres. I.E.E., 82, Victoria-street, Westminster, S.W.

ALAN ARCHIBALD CAMPBELL SWINTON, M.Inst.C.E., M.I.E.E., M.I.Mech.E., Assoc. Inst. N.A., 66, Victoria-street, Westminster, S.W.

GOTFRED MIDGLEY TAYLOR, M.Inst.C.E., Caxton House, Westminster, S.W.

ALFRED HERBERT DYKES, Assoc.M.Inst.C.E., M.I.E.E., 11, Victoria-street, Westminster, S.W., Honorary Secretary.

UNIVERSITY COLLEGE.

The work of the second term at University College began on Tuesday last. The following special and advanced courses have been arranged in the faculty of engineering: "Illumination and Photometry," by Mr. W. C. Clinton, on Wednesdays, at 6.30 p.m.; "Water Supply, Sewerage and Lighting," by Mr. R. E. Middleton, on Thursdays, at 9 a.m. and 4 p.m.; "Waterways, Harbours and Docks," by Mr. A. T. Walmisley, on Tuesdays and Thursdays, at 5 p.m.; "Heating and Ventilating Engineering," by Mr. A. H. Barker, on Wednesdays, at 7 p.m., beginning January 17; "Theory and Practice of Aviation," by Mr. A. R. Low, on Fridays, at 5.30 p.m., beginning February 2. Full particulars of all the above courses, as well as of the other work of the faculty, may be obtained on application to the Secretary of the College.

The Urban District Council of Erith, as will be seen by a notice in another column, is inviting applications for the post of chief assistant electrical engineer at a salary of £200 per annum.

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Electrical Progress at Home and Abroad.

UNITED KINGDOM.

Lighting, Power, Telegraph, Telephone, and General Business Notes.

BIRMINGHAM.—At the meeting on Tuesday of the City Council the Electric Supply Committee reported with reference to the proposed Harborne sub-station that they anticipate that they will shortly be called upon to supply current to tramways in Harborne, and in consequence a larger installation of plant must be provided. They propose to build a sub-station capable of accommodating the extra plant now contemplated, and also any further plant that may be required for general extension in the district. They have therefore obtained tenders for the building required, and have provisionally accepted one which, including architect's fees and 5% for contingencies, amounts to £6,915. The Committee recommend that they be authorised to erect this sub-station at the cost stated. They also recommend the purchase of a piece of land in Percy-road, Greet, for the erection of a sub-station to provide a supply in Greet and Wake Green. The Committee state that the demand in the Aston Manor area is so great that they have been unable to cope with the applications that have been received from power users in that district, and it has become urgently necessary for further plant to be installed there. As it is contemplated that the Aston Manor generating station will ultimately become a transforming station, the Committee are of opinion that any further plant installed should be of a type which will be permanent. They recommend that the supply be supplemented from the Summer-lane station, and that for the purpose high-tension trunk mains be laid down connecting the two stations, and that two 1,500 kw. rotary converters and transformers be installed at the Aston Manor station, from which the supply can be distributed in the Aston and Erdington district. They have obtained tenders for the two rotary converters and transformers which, with the necessary switchgear, will cost £7,531. The cost of the high-tension trunk mains from Summer-lane to Aston Manor is estimated to be approximately £5,500. The Committee recommend that they be authorised to carry out these extensions. In consequence of the increase in the load, the present plant capacity of the Handsworth generating station provides a very small margin for spare. The Committee are satisfied that it will be more economical to generate the current at the Summer-lane station and transform it at the Handsworth station than to extend the generating plant at the Handsworth station. They have obtained tenders for induction motors, to be coupled to the generators at present installed at Handsworth, and also for two rotary converters with the necessary switchgear. The total cost of this plant is estimated at £4,428. The cost of the high-tension trunk mains from Summer-lane generating station to the Handsworth station will be £6,600. The Committee recommend that they be authorised to lay these mains.

BOOTLE.—At a meeting of the Council a resolution was moved by Mr. J. W. King, deputy-chairman of the Electric Power and Lighting Committee, authorising the purchase from the Earl of Derby, as a site for electricity works, freehold land at the corner of Hawthorn-road and Marsh-lane, containing, approximately, 9,450 square yards, at the price of £6,500; and approving the scheme for the extension of the electricity supply works submitted to the Council in December last, with such modifications as may be found necessary or desirable; instructing the Finance Committee on the necessary sanction being given to take up on loan a sum not exceeding £41,255. He said that the necessity of the extension had been urged upon the Electric Lighting Committee and the Council by Mr. Clothier, the Borough Engineer, as far back as last May, and the Council were then fully satisfied that the extension was really necessary. The present works were not to be abandoned, but to be used as a supplementary station. With reference to the financial position, the borough accountant pointed out in the last annual abstract of accounts that the gross profit for the year from the electricity undertaking amounted to £10,156 19s. 3d., 8.83% of the average capital outlay. After deducting loan charges, there was remaining a net surplus of £3,800, and of this amount £2,300 was transferred to the reserve and renewal funds, and £1,500 was contributed towards the general district rate. On the motion of Mr. Randall, however, it was agreed that an independent electrical expert be appointed to criticise the scheme, that such an expert be a practical engineer in charge of an electric works giving a public supply, and that he be appointed by the president of the Municipal Electrical Association.

BRAY.—The Urban Council has decided, in view of the progress made by the electricity undertaking and the increasing demand for current to apply to the Local Government Board for sanction to borrow a sum of £3,500 for extensions. Mr. T. Picton Bradshaw has given notice that he will attend the Local Government Board inquiry and oppose the application.

CHELTENHAM.—The Local Government Board have authorised the Council to negotiate a loan of £1,250 for the purchase of a motor generator, to be repaid in 17 years. The Electricity Department is about to introduce prepayment meters to facilitate the introduction of electric lighting in small houses.

HALIFAX.—A new scale of charges is proposed for consumers of current for power purposes. The new scale ranges from 2d. per unit for accounts under 200 units per horse-power demanded per quarter, to ¾d. for accounts of 550 and upwards. These charges will be subject to the existing discount of 5%, and a special and additional discount rising from 5% for 20 to 30 h.p. demanded up to 30% for 200 and upwards. Special discounts only become operative if the consumer takes and pays for 125 units per h.p. demanded. Consumers having a maximum demand of not less than 100 h.p. will be allowed to use the current for any purpose at power rates. The new scale of discounts is modelled on that at Bradford. The committee have decided to order a second turbine to cost £9,200, which it is proposed to pay for out of revenue.

HIGHAM FERRERS.—The Council has decided to oppose the application of the private company which is seeking a Provisional Order to supply Rushden and district with electric light unless a clause is inserted empowering the local authorities to purchase the undertaking in thirty years. A deputation of the promoters, comprising Messrs. J. Clark, Brown, and Jackson, assured the Council that their intention was to proceed with the necessary works as soon as they obtained the order, and they hoped to be in a position to supply electricity in April, 1913, but were not willing to concede a right to the local authorities to purchase the undertaking in a less period than that fixed by Act of Parliament, namely, 42 years. The application will therefore be opposed.

HULL.—The Annual Social Evening of the Corporation Electricity Department was held on Friday last and was as usual a great success. Mr. Alderman Hanger, Chairman of the Electricity Committee, the Mayor and Mayoress, and Mr. H. Bell, the Electrical Engineer, were among those present.

NEWPORT (Mon.).—In his seventh annual report the Borough Electrical Engineer and Tramways Manager, Mr. Collings Bishop, states that in the electricity department the costs have been reduced to 0·75d. per unit sold—the lowest ever recorded at Newport. The net profits have gone up with a leap, and the result was a profit of over £2,600. The net profit on the tramways showed a reduction, and the engineer says the Corporation must be prepared for possible reductions in the future, due to the abnormal rise in track repairs, car repairs, and wages. The total net profit made by the tramways since they were electrified has been £11,901. The electricity department since its inauguration in 1903 has shown a loss of £1,375.

QUEENSBURY.—At a meeting of the District Council on the question of an electricity supply for the district it

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was reported that in answer to an inquiry as to terms, Messrs. Foster & Sons, of Black Dike, stated that they were not in a position to offer a supply of electricity at present, but might be able to do so at a later date. The Bradford Corporation's Electrical Engineer, Mr. Roles, replied, stating that the Corporation would have to lay a special cable from Southfield-lane to the Council's area, about two and a half miles, and it would be necessary to erect a transmitting station. The cost would be about £500, and the Queensbury Council would have to guarantee 20% on the capital outlay, but that would be waived if Messrs. Foster would take 100 kw. at a charge of £3 per kw. A reply was also received from Halifax, stating that they were unable to entertain the question. The General Purposes Committee will therefore consider what further steps can be taken.

TIREE.—For some two months the island of Tiree was without telegraphic communication owing to the breakdown of the short cable which spans the sound between Coll and Tiree, and the inhabitants sent a petition signed by 500 of the adult population to the Postmaster-General asking that the benefits of a wireless installation similar to that in use at Tobermory and Lochboisdale should be set up in Tiree. The Tiree cable has now been restored by the staff on board H.M. cable ship Monarch. The short cable was found broken one-third of its length from the Tiree shore, and the necessary repairs were promptly executed and communication restored.

WORCESTER.—At a meeting of the City Council the High Sheriff, as Chairman of the Electricity Committee, moved that the Electrical Engineer be authorised to complete the change over from the single to the two-phase system in 1912, instead of during the next three or four years. The reason was because the unexpected and unprecedented demand for current made it imperative that the work should be carried out forthwith. He reminded the Council that, in introducing the change fron the single to the two-phase scheme, there was an estimate made that, besides Messrs. Heenan and Froude's contract of £1,300 and £1,400, they might, in two years, have contracts for current of the value of £300 a year. Before they had even got their plant started, they had, in addition to Messrs. Heenan and Froude's contract, secured business to the extent of £730, and they were negotiating for a further supply of £650. Therefore he thought that the Electricity Engineer deserved every congratulation on his success. The Mayor seconded, and the resolution was adopted.

WREXHAM.—At a meeting of the Council Councillor Sauvage moved a resolution of the Electricity Committee providing that the charges for the supply of electrical energy to private houses, where based on the assessable value of such houses, be varied on and after April 1, 1912, in the following manner, namely, a minimum annual charge equivalent to 12½% of the rateable value of the house supplied shall be paid in the following proportions: for the June quarter, one-sixth; for the September quarter, one-sixth; for the December quarter, one-third; for the March quarter, one-third; the consumer to be entitled to a supply of 48 units for all purposes in respect of every £1 of such minimum annual charge, and the energy so supplied to be distributed as between the various quarters of the year in the same proportions as above mentioned. And a charge of 1¼d. per unit for every unit in excess of the 48 units referred to subject to the usual discount of ¼d. for each unit charged for. The object of the concession is to increase the number of private house consumers. The resolution was adopted.

TRACTION NOTES.

ABERDEEN.—The Tramways Committee of the Council has unanimously resolved to recommend the introduction of the trackless trolley system for Footdee. Mr. R. S. Pilcher, the Tramway Manager, in his report on the subject, points out that the great advantage of the system is the low capital cost. For two cars the total outlay would be £2,650, the cars costing £700 each, and the overhead equipment for the distance proposed, namely, 1 mile 33 yards, £1,250. In addition, £400 would have to be allowed for the cost of the Provisional Order. The capital charges per annum would be under £265, and the working expenses, £1,177, a total of £1,442.

BELFAST.—After a protracted discussion the County Borough Council has adopted the minutes of the Tramways and Electricity Committee recommending that the extension of the tramways be put in hand forthwith. The opposition to this course was mainly based on financial grounds and it was contended that the schemes for flood prevention (to cost about £80,000) and drainage improvements (about £150,000) were much more urgent than the tramway scheme. An amendment to refer the question to a committee of the whole Council was, however, defeated by a large majority.

DARLINGTON.—The Tramways Committee of the Council is faced with various demands for lower fares and more frequent services, to which Mr. Lunn, the Tramways Manager, offers the just and cogent objection that they cannot be conceded without increasing the loss on the undertaking. Applications had been made for through workmen's cars from Eastburne to Harrowgate-hill at a penny fare. Mr. Lunn's report pointed out that the route in question was 2½ miles. and that all the workmen's fares were at present at the rate of ½d. per mile, the standard rate fixed by the Light Railway Commissioners, and if departed from in one instance, it would be very difficult to refuse to make further concessions in the same connection. Referring to requests for a five minutes' service through to Harrowgate-hill, Mr. Lunn gave statistics to show that it would not pay to run such a service. "I know of no town," he added, "where a regular tramway service as frequent as every five minutes is run over a section similar to that between St. Paul's Church and Harrowgate-hill." None of the complaints with regard to the tramway service, Mr. Lunn concluded, could be satisfied without increasing the loss on the undertaking, and in his opinion no further alterations or concessions should be made in the service or fares for the convenience of certain passengers unless they could be made without the risk of increasing the existing annual deficit. Discussion was deferred.

LONDON.—The Board of Trade has under consideration a strongly-worded memorial from the Roads Improvement Association, an incorporated body which embraces within its membership the Royal Automobile Club, the Automobile Association and Motor Union, the Cyclists' Touring Club, the National Cyclists' Union, the Commercial Motor Users' Association, the National Traction Engine Owners' and Users' Association, the London Motor-Cab Proprietors' Association, protesting against the obstruction of traffic in congested centres caused by the L.C.C. tramcars. The memorial states, inter alia, that in Theobald's-road, corner of Bedford-row, observation was taken from eleven o'clock in the morning to six at night on a showery day, and whilst the total number of cars passing to and from the City varied between 96 and 144 each hour the greatest number of passengers going both ways was 33 in an hour. In City-road the figures were even more striking, the greatest number of cars in an hour being 171, and the largest total of passengers 16. It is suggested by those responsible for the memorial that from 30% to 50% of the observed tramway carriages should be kept out of service and retained in the depots between the hours of, say, 11 a.m. and 4 p.m., and the roadways thereby relieved to that extent.

NEWCASTLE-ON-TYNE.—At a largely-attended public meeting it was unanimously determined to appoint a deputation to wait upon the Tramways Committee to urge the issue of quarterly, half-yearly, and yearly contract tickets for travelling on the trams between the city and the various suburbs, such tickets to be on similar lines to those now in use on the North-Eastern Railway. The meeting made the request on the grounds that this concession is due to the ratepayers, and especially to those who regularly use the trams between the city and the suburbs, and that the granting of this concession would be a sound business action on the part of the tramways department, inasmuch as it would lead to a large increase in their turnover at a profitable rate.

PERTH.—A discussion of considerable importance to tramway undertakings has been given by Sheriff-substitute Sym in a case in which a Mrs. Duff sought to recover £55 from the Town Council in respect of injuries and loss sustained through the alleged negligence of the Council's tramway employees in failing to stop the car, by which she was travelling, at the proper stopping place, with the result that in alighting she was thrown heavily to the ground

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and seriously injured. The Council denied liability, and pleaded that the woman's injuries were caused by her own misconduct through leaving the car while it was in motion. The Sheriff-substitute sustained the plea, dismissed the action, and found Mrs. Duff liable in expenses. In a note the Sheriff says that the duty of the claimant was to remain in her place of safety until the car stopped. If the conductor was wrong and the wrong cost her loss she could have made a claim for that. The immediate cause of her injury was her own unnecessary act.

YORKSHIRE NOTES.

Leeds Electricity Profits and the Rates—Some Local Government Board Criticisms and a Reply.

Lively interest has been aroused in Leeds by some criticisms which were passed by Mr. H. R. Hooper, M.Inst.C.E., of the Local Government Board, with regard to Corporation finance in respect of the electricity undertaking. The Corporation had applied for sanction to borrow £40,000 for extensions to mains, £10,000 for the equipment of sub-stations, and a further £10,000 for the laying of services, and Mr. Hooper, by whom the inquiry into this application was held, elicited the fact that the city's total indebtedness is £13,139,228, exclusive of loans not taken up, of which there remains £1,684,953. The rates in the present year in the Leeds township were 9s. 4d. in the pound, but the rates varied in the several districts from 8s. 9d. to 10s. 4½d., and the average was 9s. 5¼d. A penny in the pound was estimated to produce £7,805 for consolidated rate purposes.

The capital charges, said Mr. Hooper, were double the cost of production. These charges were 1d. per unit on 14 million units, which absorbed about £60,000 a year, whereas the cost of production was only about half that sum. He thought their charges stood very high in comparison with other municipal undertakings in the country. On their undertaking they were making a profit of £10,000 a year and they were coming to the Board, in effect, to borrow money to make a contribution to the Leeds rates. That was what it amounted to. What was the object? It only cost the city more. There was no reduction of rate: there was an increase, because they were increasing the borrowing powers on this electricity undertaking in order to make this contribution to the relief of rates. The undertaking had a very large surplus revenue which apparently had been placed altogether to the relief of rates. A portion of the ratepayers of Leeds were thus required to contribute largely to the general rates of the whole city. The £60,000 asked for was further to increase the indebtedness of the city and the rates, for they could not borrow that sum without paying for it. Leeds was one of the few cities left in the country who were still purchasing meters out of borrowed money. What had been the result? Other local authorities were paying for most of their services out of revenue; because they saw that within a few years that policy would reduce their capital charges. Cheap power, he added, was the very life blood of a manufacturing city, and yet this £10,000 surplus had been devoted to the relief of the general rates. He made the proposition that Leeds should follow the example of other local authorities, who were far less satisfactorily situated than the Leeds undertaking was, and purchase meters in future out of revenue. Meters that once cost £5 to £7 each could to-day be bought for 38s.; so that the prime cost had dropped to an enormous extent. Was it policy to go on borrowing? If they valued their meters to-day did they think the asset would balance the liability? What he suggested was that they should stop borrowing further money for meters. They had £8,000 in hand of the loan granted in 1903, and which had then to be expended in three years. They should make payment for services out of revenue, and the £10,000 applied for that purpose should be withdrawn.

Alderman Kinder, the Chairman of the Finance Committee, in the course of a subsequent interview, took strong exception to Mr. Hooper's attitude. In suggesting that the Corporation was making an annual profit of £10,000, and, in effect, was going to the Local Government Board to ask sanction to borrow money with which to make contributions to the rates, the Inspector, said the Alderman, was travelling outside his province. He seems to be arguing what he would like to be the law, but what is not the law. His duty when he comes to Leeds, or any other place, to hold an inquiry of this kind, is to see that the request of the Corporation is within the law and within its powers, and, being satisfied on these points, to report to the Board that the application is in order.

The Electric Light Clauses Act, 1899, says: "The undertakers, that is, the Corporation, shall carry the net surplus remaining in any year, and the annual proceeds of the reserve fund, when amounting to the prescribed limit, to the credit of the local rate as defined by the principal Act, or at their option shall apply that surplus or any part thereof to the improvement of the district for which they are the local authority, or in reduction of the capital moneys borrowed for electricity purposes: provided always that if the surplus in any year exceed £5 per centum per annum upon the aggregate capital expenditure on the undertaking, the undertakers shall make such a ratable reduction in the charge for the supply of energy as in their judgment will reduce the surplus to that maximum rate of profit." Under this clause, said Alderman Kinder, the Corporation was entitled, assuming it earned the money, to take 5% on the aggregate capital to the relief of rates, if it thought fit to do so. "The aggregate capital of the Leeds Electric Lighting undertaking," he added, "is £1,059,768; so that under the Act of Parliament the Corporation is entitled (if it makes the money) to take to the relief of rates the sum of over £50,000 per year. Yet the Inspector himself admits that we have never taken more than £10,000. But the Act of Parliament goes on to say: 'Any deficiency of income in any year, when not answered out of the reserve fund, shall be charged upon and payable out of the local rate.' So that according to the Inspector's view the Corporation is not to take advantage of the Act of Parliament which says that surplus profit shall go to the relief of rates, but is left with the obligation that if there is a deficiency the general ratepayers must meet it. This is a question of policy and not a matter of legal inquiry. As a matter of policy, his view may be worthy of great consideration, but it is really a matter to be determined by the Corporation, and the Corporation has to treat its finances as a whole and not in parts. It may be that in some years, when everything is going well and the various concerns are making huge profits, that the Corporation would do out of revenue account some of the things which the Inspector suggests ought properly always to be charged to revenue, but such is not the law of the land, and, therefore, whilst the Corporation might do some of these things in fat years, it ought not to be deprived of its legal rights in lean years, nor be subjected to criticism because it exercised these rights. The Inspector's proposition comes to this: (1) That present-day ratepayers are to be asked to pay more; or (2) that users of electricity are to be asked to pay more, in order that the ratepayers or the users of electricity of the future may pay less. Because it is obvious that if the charges for services—that is, the coupling up of each individual user to the main or mains—are to become revenue charges, then the cost of electricity must be proportionately advanced to the user, or the ratepayer must make up the difference from the rates. In other words, assuming there is a surplus the ratepayer will not get that relief in rates to which he is entitled, and to which I think he is justly entitled, having regard to the fact that in case of any deficiency he must make it good. This seems to me to be neither justice nor equity. But in any event it is purely a matter of policy, and one for decision by the Corporation, and is not in my view a proper subject of comment by a Local Government Board inspector, whose sole province is to see that the application of the Corporation is within the law, and within the borrowing powers authorised by Parliament."

AMERICAN NOTES.

Neon Vapour Lamps—Consumption of 0·8 Watts per candle—The Education of Electrical Engineers—Getting Out of the Rut.

In an interesting note on lamps of luminescent neon vapour the "Electrical World" observes that it is well recognised that there is a better chance to develop a highly

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efficient incandescent electric lamp with a column of vapour than with a solid filament. This is for the reason that there is only one known way of making a solid filament give out light, and that is by heating it to the incandescent temperature. There is no known way of keeping a substance at the temperature of incandescence without radiating from the substance a relatively large amount of dark heat or non-luminous radiant energy. On the other hand, a gas can be made luminescent in such a way that it radiates energy selectively, and perhaps entirely in luminous form. In other words, the spectrum of a white-hot solid is a continuous spectrum all the way from the high frequencies, in the treble which the eye perceives, down to the deep bass of low-temperature radiation, and the treble notes cannot be held down without holding down the entire keyboard along with them; whereas a luminescent gas radiates in a certain line spectrum or band spectrum only, so that the treble frequencies sought for may be obtained without any wasteful and unnecessary bass accompaniment. A preferred size of neon vapour lamp appears to be a tube about 6 m. long and 45 mm. in diameter, operating at an alternating terminal E.M.F. of about 1,000 volts. It is claimed that these neon lamps can operate for 800 hours at a specific consumption of 0·8 watt per candle at primary terminals of the special set-up transformer. At lamp terminals this would be about 0·75 watt per candle. Many difficulties have had to be met in producing a neon vapour lamp, and this low specific consumption is thereby the more remarkable. [The lamps referred to are those invented by M. Claude, the French chemist, of which mention has already been made in these columns.]

The Higher Engineering.

In connection with recent discussions (referred to at some length in these Notes) on education for the electrical engineer, the "Electrical Review," of Chicago, has some very sane observations to make. In one of these discussions a leading university authority divided College-trained engineers into two classes—those who design and construct engineering structures as well as is possible according to existing standard practice, rules and customs, and those who endeavour to improve upon former methods and to develop new departures. Both classes are very necessary, or if there is any difference in importance, the former is the more essential, besides being by far the larger one. The duty of the one is to study existing practice carefully and thoroughly so that his work will be the best that can be done with existing knowledge. The duty of the other is to go more deeply into the subjects and find out whether existing practice is really the best, and whether it can be improved upon by new departures, sometimes perhaps of a revolutionary character. The former, although doing good work, is working in a rut, while the latter tries to climb out of the rut to see whether there is any better ground to work in elsewhere. A rut has been defined as "a grave, only it's longer." On the other hand it is the rut in a grooved rail that keeps the train on the track. Both classes have existed for a long time, but until recently the one has been somewhat sneeringly referred to as a class of theorists, or wild inventors, and their ideas have been looked upon as visionary, impractical and useless. In the earlier days this was not entirely without justification owing often to the lack of appreciation which the so-called theorist had of the requirements of successful practice, and owing to the prominence of the uneducated inventors of the perpetual-motion class. In later times, however, the plodding, patient, ceaseless work of the searchers for new truths, often done with a purely altruistic spirit, has become recognised and appreciated more and more.

An Evolutionary Change.

This change of attitude the Chicago "Review" attributes in large part to the fact that many of the studies of the scientists have turned out to be of great commercial value, as is evidenced for instance in the transmission of intelligence by means of waves of ether; also to the fact that the public at large, including the capitalists, is becoming better educated and is beginning to have more respect for higher intelligence; but, on the other hand, the so-called scientific man to-day has a better realisation of the requirements of successful practice. "The electrical engineer has gotten the steam engineer out of his rut, resulting in very great improvements in engines; the scientific study of the velocity of the particles of steam has led to the useful steam turbine; the scientific study of the rare earths by the chemist has led to a more efficient gas lighting which in turn has urged the electrical engineer to study his lamp more scientifically, resulting in the tungsten lamp. The great value of the higher class of scientific research has in fact now been so fully recognised that some of the larger companies have found it profitable to maintain regular research laboratories, in some of which a very high class of scientific work is done." The so-called "scientific management" which is meeting with increased favour by the more progressive, when not overdone, is another instance showing how the more highly developed scientific training can be applied to business management. This change has led to what might now be called "higher engineering," that is, that branch of engineering in which the higher education of the engineer, physicist or student is applied to the development of new departures from standard practice; to progress as distinguished from mere maintenance. The evidence of this can be seen everywhere, and it appears to be greatly disturbing the self-satisfied business men who had settled down comfortably to routine practice based on the standards of the past; and who now find themselves rudely awakened to recognise that they have been asleep in a rut and that they must now do some hustling to keep up with those who are awake and more progressive. The first attempt of those thus disturbed was to try to stifle the more progressive by coercion and greater power of control, but the strongest walls must ultimately break down under a persistently increasing and accumulating force, and the most effective of such forces is the power of the higher intellect.

REVOCATION OF PATENT.

Some interesting questions in Patent Law and practice were involved in a case which recently came before Mr. Justice Parker. The patent in question was one (Number 27147 of 1910) granted for improvements in automobiles carrying pumps, and the alleged invention appears to have consisted in driving the pump by means of a chain. Messrs. Hans Renold, Ltd., who are manufacturers of driving chains, applied to have this patent revoked. In their view the mere substitution of chain driving for some other method of driving, such as by belt or spur gearing, in connection with any particular class of machines was not proper subject matter for a patent. It was a substitution already made in connection with many different machines, and one which might hereafter be made in connection with many others. To grant patents in such cases would hamper the development of the chain making industry. They accordingly petitioned for the revocation of the patent on the ground of want of novelty, prior publication and use, and that the alleged invention was not a proper subject matter for a patent. When the case came on the patentee consented to the patent being revoked, but in connection with the question of costs, raised an objection that the petitioners had given no notice to him of their intention before commencing proceedings. If they had done so, then he contended he might have surrendered the patent and saved some expense. The judge, however, allowed the costs of the petition, remarking that it is doing a kind of public wrong to maintain a patent on the rolls when that patent is void. This case illustrates the fact that it is too easy in this country to obtain patents which cannot be sustained, but which while they are in existence must operate as a check upon legitimate industry.

ROYAL EDISWAN METAL LAMPS.

Further to the interesting results of tests recently published, carried out by a large municipal supply station on Royal Ediswan metal (tungsten) filament lamps, the company have just received the following letter from the engineer of one of the principal supply authorities:—"With further reference to the life test made on a 35 watt 105 volt 'Royal Ediswan' metal filament lamp, it may be of interest to you to learn that the lamp gave out after burning continuously for 6,970 hours."

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THE NEW INSULATOR.

Remarkable Laboratory Tests of "Seagumite."

Reference was made in last week's issue of the ELECTRICAL ENGINEER to the immense field of usefulness which appears to be open for the new insulating material known as "Seagumite," a product evolved out of the chemical treatment of seaweed, which is converted into a material possessing insulating properties of exceptionally high value. We are now, through the courtesy of Lord Tenterden, able to supplement the particulars then given and to present a number of interesting details relating to this remarkable invention.

The inventor is Mr. John Stuart Campbell, a well-known London chemist, who describes Seagumite as a non-inflammable, impervious, leather-like, damp-proof, germ-proof and hygienic composition, unaffected by heat, cold, oils, or exposure to weather. It can be used successfully in all parts of the world, in hot climates such as India, South America and the West Indies equally as in the colder climates, and will stand perfectly good where ordinary rubber and leather will absolutely perish. According to a report made at the Westminster Testing Laboratories, "Seagumite" stood a test of 32,000 volts, proving its great value for all electrical purposes. The tests were three-fold, and demonstrated that the material has beaten all compositions for electrical purposes up to the present day. A singular fact was also noted, namely, that its insulating properties are greatly enhanced after the material has been immersed in water. This latter feature would make it very valuable for submarine cables, and there will no doubt be a great field for it in this connection, while the additional fact that it is non-inflammable and absolutely impervious to weather renders it practically invaluable for electric work generally.

There can be no question as to the non-inflammability of "Seagumite," for the writer saw a piece of the material placed in a red-hot gas stove and left in the flames for nearly an hour, and no change whatever took place in the material.

As already mentioned, at the Westminster Electrical Testing Laboratory seven samples of this material were tested for insulation resistance with very striking results. The Chief Electrician, Mr. Lancelot W. Wild, A.M.I.E.E., says in his report :—

"The samples were first of all cut down to one uniform size, namely, 5 in. by 3½ in. A piece of damp blotting paper, measuring 3½ in. by 2 in., was next laid on each side of the samples, and a guard ring, also of damp blotting paper, was arranged round the outer edge. The insulation resistance was then measured between the two sides, first, with the guard ring connected to the battery side of the galvanometer, and secondly, with it disconnected from the circuit. The former test gave the leakage through the material itself, and the latter the leakage over the surface of the material.

"The first series of tests were made on the samples as received. The second series of tests were made after twenty-four hours' immersion in water. The surface was wiped dry after removing the samples from the water, but received no further treatment. The third tests were made after the samples had been exposed to the air outside on the window ledge for three hours. This treatment followed immediately after the second series of tests had been made. The fourth tests were made after the samples had been baked for fifteen minutes, and then allowed one hour to cool. The fifth series of tests were made after the samples had been standing in the laboratory for a further period of forty hours.

LEAKAGE THROUGH MATERIAL.

Sample Nos.	1st Test. meg.	2nd Test. meg.	3rd Test. meg.	4th Test. meg.	5th Test. meg.
1	35	150,000	250,000	350,000	500,000
2	16	150,000	250,000	250,000	250,000
3	1.6	250,000	350,000	500,000	750,000
4	8.8	250,000	500,000	750,000	500,000
5	.8	200,000	350,000	500,000	250,000
6	10.6	250	150	2,500	5,000
7	43.0	140,000	500,000	750,000	1,000,000

"The above figures must be taken as approximate only, as with the exception of the first test and No. 6 sample, the figures obtained are beyond the range at which exact measurements can be made.

SURFACE LEAKAGE.

Sample Nos.	1st Test. meg.	2nd Test. meg.	3rd Test. meg.	4th Test. meg.	5th Test. meg.
1	8.5	1,400	200	120,000	50,000
2	3.8	10,000	125	50,000	17,000
3	.9	1,700	300	10,000	5,000
4	3.5	3,400	1,000	1,200	2,000
5	.4	7,000	2,000	55,000	50,000
6	2.5	17	200	1,500	5,000
7	8.0	5,000	3,500	5,000	5,000

"The great increase of insulation resistance after immersion in water is, as far as our experience goes, contrary to all precedent, and at first sight is indicative of some error having been made in the method of carrying out the tests. That this increase was a fact, and not due to error, we have proved by re-testing a second piece of No. 1 sample, which had been simply standing idle in the laboratory. This piece of material was found to have remained practically unaltered during the whole course of the tests, having, in fact, about the same insulation resistance as the other part of No. 1 sample had at the commencement.

"The samples were next tested for dielectric strength. For this purpose small pieces were cut from the samples and were filed down to a uniform thickness of one millimetre. The tests were made as follows: One sample was laid upon a metal-faced plate. Paraffin wax was next run all round the edge of the sample in order to prevent sparking over the surface of the material. A scriber point was next arranged to make contact on to the top of the sample. Alternating voltage was next applied between the face plate and the scriber point. The voltage was raised gradually till the material under test was punctured.

"The results of the tests were as follows:—No. 1 sample broke down with 12,000 volts; No. 2 with 10,000; No. 3 with 15,000; No. 4 with 12,000; No. 5 with 11,000; No. 6 with 9,000; No. 7 with 16,000.

"The general conclusions to be arrived at from the above figures are as follows:—With the exception of sample No. 6, the insulation resistance of the samples through the material is extremely high after the material has once been immersed in water for twenty-four hours, being, in fact, of the order of 30,000,000 megohms per centimetre cube. The dielectric strength is extremely high, and is, in fact, much higher than is ever likely to be required in practice. The very great increase of insulation resistance after immersion in water is quite abnormal, and is to us at present inexplicable."

A further test is thus reported on by Mr. Wild :—

"On receipt of the sample, our first step was to cement on to each face an aluminium foil disc measuring 2 in. by 1 in. A guard ring also of aluminium foil was cemented round the edge of the disc to intercept surface leakage. The sample consisted of a rectangular disc 3 in. long, 2 in. wide and .313 in. thick. We next measured the insulation resistance between the two faces, and obtained a figure of 310,000 megohms with the guard ring connected, and 620 megohms when it was disconnected. The latter figure would represent the surface leakage, and the former the leakage through the body of the material. The testing pressure was 1,500 volts, taken entirely from accumulators.

"The sample was next immersed in salt water for 24 hours. On removing it from the water we first dried it by wiping, and then tested it again, under the same conditions as before. We obtained 290,000 megohms with the guard ring and 480 megohms without it. After standing in a free current of air for three hours, the sample was again tested, and came out to 450,000 megohms with the guard ring, and 3,300 megohms without it.

"The sample was next baked in front of a gas fire for 15 minutes, and after being allowed to stand for one hour, was again tested, and came out to 550,000 megohms with the guard ring and 350,000 megohms without it.

"The next test was to endeavour to break down the sample. The material was clamped between two aluminium points, and these were connected to the secondary of a transformer. The pressure was applied gradually. When the voltage had reached 32,000 a spark passed through the air round the material. The dimensions of the sample were not sufficiently large to stop this charge, and so the voltage could not be increased above this limit. In order to ascertain at what voltage the sample really would break down, a thin shaving was cut from the material, and this

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was tested separately. The thickness of this shaving was .041 inch, and it broke down with 15,500 volts alternating of 120 periods."

The uses to which this material can be put are practically unlimited. Motor and carriage tyres and covers made with "Seagumite" have all the durability of other materials and cost two-thirds less than the tyres in use at the present day. "Seagumite" can be used also as a substitute for steam jointing and packing, and as an alternative to leather in the manufacture of boots is, it is claimed, cheaper, more hygienic, and more durable. It is also particularly suitable for belting for machinery, as it possesses great tensile strength and durability, is non-slipping, and is not affected by oils, chemicals, or weather, and for this latter qualification alone should make an excellent material for roofing in any part of the world.

This remarkable product is being put upon the market by the British Seagumite Company, Ltd., of 26, Shaftesbury-avenue, W.C.

ELECTRICAL TRADES' NEW YEAR'S GIFTS.

SECOND NOTICE.

Herewith we continue from last week our acknowledgments of the Electrical Trades' New Year's gifts.

The BRIMSDOWN LAMP WORKS, Ltd., send a pack of playing cards of exceptionally excellent quality, backed with reproductions of their famous "See things in a better light" poster.

From the BRIMSDOWN COMPANY there also comes a very charming and ingenious memento in the form of a table cigar-lighter in which the principle of the pocket magic lighter is carried out in the shape of a pedestal and ash tray fashioned out of aluminium. It has, however, this advantage over the ordinary pocket lighter, namely, that the spark is produced by the impact of corundum and steel, and the means of lighting is thus practically indestructible.

The UNION ELECTRIC COMPANY'S device takes the form of a number of small and very handy memo pads for desk use.

From Messrs. SIEMENS BROS. & COMPANY, Ltd., and Messrs. SIEMENS BROS. DYNAMO WORKS, Ltd., comes the morocco leather-bound pocket diary which always proves so welcome a gift at this time of year.

The DUSSEK BITUMEN COMPANY, of Canal Bank, Deptford, London, S.E., also send a morocco covered back-loop, self-opening pocket diary—one of Charles Letts's well-known series, which carries with it a £1,000 accident insurance policy. A similar gift comes from Messrs. MCCLURE & WHITFIELD, of the Mersey Dynamo Works, Adswood, Stockport.

From Messrs. S. DAVIS & Company, of 30 and 31, St. Swithen's-lane, E.C., we have received the Electrical Engineers' Diary for 1912, the well-known large 4to volume which has proved so indispensable to consulting engineers, electrical contractors, central station engineers, and all users of electrical apparatus. Apart from the actual diary pages (which are square ruled, three days to a page), the volume contains nearly 200 pages of information of extreme value to all concerned in the electrical industry, this includes a concise, but very complete directory of electric supply authorities, the system of generation, price of current etc., a directory of electrical manufacturers, the Home Office Regulations, and a copious account of the application of electricity to various industries in addition to a number of important tables, etc.; on the whole a wonderful half-crown's worth.

From the BRUSH ELECTRICAL ENGINEERING COMPANY, LTD., comes a very charming little gift in the shape of waistcoat pocket diary, with back-loop, self-opening device and £1,000 policy, all complete within a space of three inches by two-and-a-half and covered in Russian leather. Equally charming is another waistcoat pocket diary sent by Messrs. JOHNSON & PHILLIPS, LTD., of Victoria Works, Charlton, Kent. This is of even smaller dimensions than the Brush diary, is covered in morocco, and gives four days in an opening.

From Messrs. VENNER & COMPANY, the well-known electric sign makers, of Old Queen-street, Westminster, there has arrived a neat and handy card and stamp case, together with this humorous history of its evolution: "Just after the Exhibition we were sitting, worn and weary, in our dress clothes (the only decent suit we had left), talking to a stranger whom we thought was an engineer because he allowed us to pay for his drink. After an interesting conversation during which we each tried to find out the other's name, the stranger made the original proposition that there was nothing like leather. Reminiscently, we conceded this. Then he asked us for our card. Now we have a bulky pocket book in which we carry our cards, but we never wear it when in evening dress because it looks as though one coat tail were fastened down with a flat iron. At that time, too, the pocket book was so bulged with Exhibition orders (h'm) that we had left it at home. Consequently there was no card available. THEN we found out who the stranger was, and the point of his conversation. Too weakened by our Olympian struggles we succumbed and gave him an order. The enclosed is the result. Never mind, we'll do better next year."

Messrs. HARRISON, JEHRING & COMPANY send a supply of telephone message pads so constructed as to hang on the hook of the second receiver.

Of wall calendars a very choice variety has come to hand. The UNITED STATES METALLIC PACKING COMPANY, Ltd., of Soho Works, Bradford, the centre-piece of whose calendar last year was a charming reproduction in relief of the famous "Paul and Virginia" statuette, have this year taken for their device the equally famous "Echo"—a girl's undraped figure in high relief, with exquisite tinting.

The PHŒNIX ELECTRIC HEATING COMPANY, of 17, Morwell-street, Tottenham Court-road, send a calendar of which the central feature is a charming reproduction in colours of Yeend King's well-known picture, "Where the Old Folks Live."

The calendar of the D. P. BATTERY COMPANY, Ltd., of Bakewell, embraces picturesque photographic views of noteworthy beauty spots on the company's Derbyshire property.

Messrs. W. T. HENLEY'S TELEGRAPH WORKS, COMPANY, LTD., Blomfield-street, London, E.C., send a very effective daily tear-off calendar with quotations from the poets.

Messrs. MERRYWEATHER & SONS, Ltd., send a calendar with striking views in colour of the Turin Exhibition, of fire engines and motor fire brigade wagons, motor launches, etc., the general effect being very attractive.

From Messrs. NALDER BROS. & THOMPSON, of 34, Queen-street, London, E.C., comes a monthly calendar block of very handy size.

Another effective and useful calendar comes from Messrs. JORDAN & COMPANY, Company Registration Agents, of Chancery-lane, while Messrs. SHAND, MASON & COMPANY, of Upper Ground-street, Blackfriars-road, send a boldly-printed sheet almanac.

An extremely handy blotter has been received from the HART ACCUMULATOR COMPANY, LTD., of Marshgate-lane, Stratford, London, E. This is an improvement on the ordinary pattern inasmuch as renewal sheets only require adjustment in two corner pockets instead of four.

Messrs. MAWDSLEYS, LTD., of Zone Works, Dursley, send a delightful reproduction in colours of Frank Haviland's clever picture of an Irish colleen, "None of your blarney."

ROYAL INSTITUTION.—On Tuesday next (January 16), at three o'clock, Professor William Bateson will begin a course of six lectures at the Royal Institution on "The Study of Genetics"; on Thursday (January 18), Professor A. W. Bickerton begins a course of two lectures on "The New Astronomy"; and on Saturday (January 20), the Rev. John Roscoe commences a course of two lectures on "The Banyoro: A Pastoral People of Uganda"—(1) "The Milk Customs"; (2) "Birth and Death Customs." The Friday Evening Discourse, on January 19, will be delivered by Professor Sir James Dewar on "Heat Problems," and on January 26, by Professor Bertram Happinson, on "The Pressure of a Blow."

The Crypto Electrical Company, of 155 to 159, Bermondsey-street, S.E., have opened a branch office at 77, Victoria-street, Bristol, where they hold a large stock of standard pattern dynamos, alternating current motors, a.c. to d.c. transformers, engine sets, etc.

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Electrical Contractors' Section.

Contracts Open and Accepted, and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

CITY OF MANCHESTER.

The Markets Committee invite Tenders for the purchase of spare plant at their Elm Street Cold Air Stores, consisting of :—

1 Babcock & Wilcox water tube Boiler.
1 Steam Engine : 160 h.p.
2 Steam Engines : each 40 h.p., together with two 100-volt Dynamos, 250 amps.
1 Small Engine.
7 Motors, 100 volts, from 1¼ to 10 h.p.
2 double-acting Ram Pumps : capacity 15,000 gallons per hour.

Particulars of the plant may be obtained on application to the Superintendent, Markets Department, Town Hall, Manchester. Tenders, addressed to the Chairman of the Markets Committee in sealed envelopes, endorsed "Spare Plant," to be delivered at the Markets Office, Town Hall, not later than first post on Thursday, the 18th instant.

The Committee do not bind themselves to accept the highest or any Tender.

THOMAS HUDSON.
Town Clerk.

Town Hall, Manchester.
January 3rd, 1912.

CORPORATION OF DUBLIN.

The Electricity Supply Committee of the Corporation of Dublin are prepared to receive Tenders for the supply of

E.H.P. SUBSTATION SWITCHBOARDS AND ACCESSORIES.

Specification, with General Conditions and Form of Tender, can be obtained from the City Electrical Engineer, Electricity Works, Fleet-street, on and after Monday, 8th inst., on payment of one guinea for each specification, which will be returned on receipt of a bona fide Tender.

Tenders addressed "Chairman of Electricity Supply Committee, 3, Cork Hill, Dublin," and marked "Tender for E.H.P. Substation Switchboards, etc.," to be received not later than noon on Thursday, the 18th inst.

The Corporation do not bind themselves to accept the lowest or any Tender, and reserve the right of accepting a Tender for any section separately if found desirable.

FRED. J. ALLAN,
Secretary.

Electricity Supply Committee,
3, Cork Hill, Dublin,
January 6, 1912.

APPOINTMENTS.

NORTHAMPTON POLYTECHNIC INSTITUTE,
ST. JOHN-STREET, LONDON, E.C.

THE GOVERNING BODY invites applications for the appointment of an Assistant Junior Demonstrator in the Electrical Engineering and Applied Physics Department. Commencing Salary £100 per annum. The particulars of the conditions of appointment, duties, etc., with forms of application, can be obtained on application in writing to the undersigned, to whom applications should be sent not later than 10 a.m. on Thursday, January 18, 1912.

R. MULLINEUX WALMSLEY, D.Sc.,
Principal.

Contracts—*continued.*

STEPNEY BOROUGH COUNCIL.

ELECTRICITY SUPPLY.

The Electricity Supply Committee of the Stepney Borough Council invites tenders from responsible contractors for the carrying out of the following work at the Council's Limehouse and Whitechapel Stations, viz. :—

The Manufacture, Supply, and Erection complete one E.H.T. Converting Plant suitable for 6,000 volt 3-phase A.C. to L.T.D.C., together with E.H.T. and L.T. switchgear, etc.

Copies of general condition, specifications, form of tender, and drawings, may be obtained from Mr. W. C. P. Tapper, A.M.I.E.E., Borough Electrical Engineer and Manager, 27, Osborn-street, Whitechapel, East, upon receipt of a deposit of 5 guineas. Deposit will be returned to bona-fide tenderer after the tenders have been considered by the Council. Additional copies may be obtained upon payment of the sum of 1 guinea, which will not be returned.

Copies of the specifications and drawings may be inspected at the above-mentioned address by application.

Tenders on the forms supplied, endorsed "Tender for Converted Plant," must be delivered, signed, sealed, and addressed to the Chairman of the Electricity Supply Committee at No. 27, Osborn-street, Whitechapel, E., not later than noon on Monday, January 29, 1912.

The Council do not bind themselves to accept the lowest or any tender, and the acceptance of any tender is subject to the sanction of the London County Council to the necessary loan being obtained.

GEO. W. CLARKE,
Town Clerk.

Municipal Offices,
15, Great Alie-street, E.
January 10, 1912.

Appointments—*continued.*

URBAN DISTRICT OF ERITH.

APPOINTMENT OF ASSISTANT ELECTRICAL ENGINEER.

The Urban District Council invite applications for the appointment of Chief Assistant Electrical Engineer, at a salary of £200 per annum.

Applicants must be thoroughly capable Electrical and Mechanical Engineers, with actual operating experience of a three-phase high tension system, and be accustomed to the sole control of workmen.

Full particulars and forms of application may be obtained from the undersigned on receipt of a stamped, addressed foolscap envelope.

Applications endorsed "Assistant Electrical Engineer," must reach me on or before Wednesday, the 24th instant.

J. KENNEDY ALLERTON,
Clerk and Solicitor.

Council Offices,
Erith, Kent.

OSRAM-LAMPS

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"THE BEST IS THE CHEAPEST."

The best text book on electricity is also the cheapest. Prof. Magnus Maclean's MODERN ELECTRIC PRACTICE is the best book because it is written by 38 recognised experts. It is the cheapest not only because accurate, reliable books are *always* cheapest, but also because, owing to the large sale which it commands, its six large and lavishly illustrated volumes can be sold at 9s. each. Anyone who needs a practical reference book on electric practice can obtain

MODERN ELECTRIC PRACTICE

ON EXCEPTIONALLY FAVOURABLE TERMS.

THE CONTRIBUTORS :—A. HAY, D.Sc., Prof. E. W. MARCHANT, D.Sc., W. C. MOUNTAIN, J. LEGGAT, E. J. BERG, A. T. SNELL, C.E., M. B. FIELD, G. G. BRAID, A. F. BERRY, J. T. NIBLETT, W. E. WARRILOW, J. C. A. WARD, W. B. ESSON, W. W. LACKIE, G. BYNG, V. ZINGLER, F. BILLIOTTI, C. J. ROBERTSON, J. R. WIGNALL, V. WATLINGTON, I. E. WINSLOW, A. G. SEAMAN, H. C. BUCKMASTER, W. W. BEAUMONT, P. DAWSON, J. K. STOTHERT, H. O. BECKH, M.A., W. H. BOOTH, J. SHIELDDS, D.Sc., Ph.D., A. C. BOOTH, DANE SINCLAIR, D. BURNS, Dr. DAWSON TURNER, B.A., W. E. LANGDON, W. B. HIRD, B.A., Dr. GOLDSMIDT, J. CAMPBELL, B.Sc., W. ALLAN.

THE CONTENTS —The above six handsome books contain, in carefully indexed form, practical advice on Measurements, Dynamos, Motors, Transformers and Converters, Storage Batteries, Switches and Switchgear, Mains, Distribution and Transmission of Energy, Lighting, Wiring, Fittings, Lamps, Tramways, Rolling Stock, Automobiles, Electric Traction on Railways, Boilers, Steam Engines and Prime Movers, Feed Pumps, Condensers, Economisers, Electricity in Mining, Cranes, Electro-Medical Appliances, Railway Appliances.

"THE ROAD CARRYING COMPANY, LTD., 68, Renshaw-street, Liverpool.

"Gentlemen,—This is the best work of its kind I have seen. As a book of reference it will be invaluable, and at the same time, although technically written, is in such a style as can be readily grasped by a student or practical working man.—Yours faithfully, ERNEST A. ROSENHEIM (Engineer)."

Two models of a Motor and a Wireless Installation respectively, in coloured cardboard, prepared specially for the work by an electrical engineer, are presented to each subscriber.

FILL UP ORDER FORM AND SEND WITH 5/- TO-DAY TO

WRITE NOW FOR AN ILLUSTRATED BOOKLET.

The Publisher, "The Electrical Engineer," 149, Fleet Street, London, E.C.

Please send me, carriage paid, MODERN ELECTRIC PRACTICE. I enclose 5/-, and agree to remit to whomsoever you may depute the same sum each month until the net cash price (5*l*./-) is paid.

Name.....

Address.....

Contracts Open.

HOME.

ASHTON-UNDER-LYNE.—The Electricity Committee of the Corporation invite tenders for three Lancashire boilers and two 1,500 kw. turbo-alternators. Particulars (£1 1s. each) from the Borough Electrical Engineer. January 24.

BURNLEY.—The Board of Guardians invite tenders for the supply of a lighting battery at the Workhouse. Particulars from Mr. J. S. Horn, Union Offices. January 24.

CROYDON.—The Corporation invite tenders for the supply of a mixed pressure turbine plant at the electricity works, Factory-lane. Particulars (£1 1s.) from the Borough Electrical Engineer. January 29.

DARTFORD.—The Urban District Council invite tenders for the supply and erection of (a) one uniflow high speed vertical engine, tandem generators, and 3-wire balancer; (b) three superheaters and extensions to pipe work; (c) switchboard; (d) electrically driven centrifugal pump. Particulars, £2 2s, from Mr J. D. Pember. Electrical Engineer. January 23.

DUBLIN.—The Port and Docks Board invite tenders for the supply of two 4-ton electric Portal wharf cranes. Particulars (£1) from Sir J. P. Griffith, M.Inst.C.E, East Water, Dublin. January 30.

DUBLIN.—The Electricity Supply Committee of the Corporation invite tenders for the supply of E.H.P. sub-station switchboards and accessories. Particulars from the City Electrical Engineer, Fleet-street, Dublin. January 18. See Official Notice.

GRIMSBY.—The Corporation invite tenders for one year's supply of metal filament lamps. Particulars (10s. 6d.) from Mr. W. A. Vignoles, M.I.E.E., Borough Electrical Engineer. January 15.

NUNEATON.—The Corporation invite tenders for the supply of one 500 kw. mixed pressure turbo-generator with condensing plant and pipework, etc. Particulars (£1 1s.) from Mr. S. C. Gibson, Borough Electrical Engineer. January 24.

Tenders Accepted.

BRIGHTON.—For the supply of one 750 h.p. three-phase induction motor for the Corporation's Electricity Works: Messrs. Siemens Bros. Dynamo Works, Ltd., £770. Other tenders were as follows: Messrs. Crompton & Company, Ltd., £875; Brush Electrical Engineering Company, Ltd., £895; British Electrical Plant Company, Ltd., £910; British Westinghouse Electrical and Manufacturing Company, Ltd., £955; Messrs. Bruce Peebles & Company, Ltd., £975; General Electric Company, Ltd., £988; Phœnix Dynamo Manufacturing Company, Ltd., £995; Messrs. Dick, Kerr & Company, Ltd., £1,172; Union Electric Company Ltd., £1,220; British Thomson-Houston Company, Ltd. £1,236; Electric Construction Company, Ltd., £1,305.

DEWSBURY.—1¼ miles of cable for the Corporation Electricity Department: The Union Cable Company, £182.

SALFORD.—Two 1,000 kw. Willans-Siemens turbo-generators supplied and erected at the Corporation Electricity Works: Messrs. Willans and Robinson, Ltd., £10,780.

MANCHESTER.—Electrically-driven pumping plant, pipe lines and storage tank at Elm-street Cold-Air Stores, for the Markets Committee of the Corporation: Messrs. Newton, Chambers & Company.

WALSALL.—Transformer and switchgear for supplying the Council's Sewage Works with alternating current: The British Westinghouse Electric and Manufacturing Company, Ltd., £74 and £55, respectively. Supplying and erecting cooling tower at the Council's generating station: Messrs. Richardson, Westgarth & Company, Ltd., £600.

WREXHAM.—Main switchboard for the Corporation's Electricity Department: Mr. B. Thomas, £762. Other tenders were: Messrs. Whippe and Bourne, £736 5s.; Messrs. Siemens Bros. Dynamo Works, Ltd., £773 10s.; The Electric and Ordnance Accessories Company, Ltd., £788 10s.; Messrs. Spagnoletti & Company, Ltd., £1,003; Messrs. A. Reyrolle & Company, £1,058; Messrs. Crompton & Company, Ltd., £1,137 3s. 6d.; The General Electric Company, Ltd., £1,197 10s.; The Walsall Manufacturing Company, Ltd., £1,305 10s.; Messrs. Ferranti, Ltd., £1,385 10s. 6d.; The Electric Construction Company, Ltd., £1,438; Messrs. Johnson and Phillips, Ltd., £1,465; The British Westinghouse Electrical and Manufacturing Company, Ltd., £1,525 4s.; The Electrical Engineering and Agency Company, Ltd., £1,743 16s.

Diary.

FRIDAY, JANUARY 12.

BATTERSEA POLYTECHNIC.—Battersea Park-road, S.W. "The Measurement of Light," by Dr. J. S. Dow, 7.30 p.m.

SATURDAY, JANUARY 13.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—St. Bride Institute, E.C. Annual General Meeting, 6.45 p.m.

MONDAY, JANUARY 15.

LEEDS UNIVERSITY ENGINEERING SOCIETY.—Paper, "The Practical Construction of a Masonry Dam," Mr. E. W. Wilson, M.Inst.C.E.

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TUESDAY, JANUARY 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Local Section).—Paper, "Recent Developments in Turbine Practice," Mr. Karl Baumann.

ILLUMINATING ENGINEERING SOCIETY.—At the Royal Society of Arts. Paper: "Colour Discrimination by Artificial Light." Mr. Thomas E. Ritchie. 8 p.m.

WEDNESDAY, JANUARY 17.

JUNIOR INSTITUTION OF ENGINEERS.—At the Institution of Electrical Engineers, Victoria Embankment. Paper on "The Sighting of Small Arms and Artillery," by Sir George Greenhill, M.A. 8.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate. Paper: "The Evolution and Present Development of the Turbine-Pump." Messrs. E. Hopkinson, D.Sc., and A. E. L. Chorlton. 8 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Victoria Embankment. (Students' Section.) Paper: "Some Notes on Central Station Practice," Mr. A. Neave Kingsbury.

THURSDAY, JANUARY 18.

IPSWICH ENGINEERING SOCIETY.—At the Museum, High-street, Ipswich. "Petroleum and other Mineral Oils: their History, Production, and Uses," by Mr. A. E. Kidner, 8 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Victoria Embankment. Ordinary General Meeting. "Residence Tariffs," by Mr. A. H. Seabrook, Member (adjourned discussion), 8 p.m.

FRIDAY, JANUARY 19.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Northampton Institute. "Reinforced Concrete Construction," by Mr. W. Hislop, 5.45 p.m.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—St. Andrew's Hall, Glasgow. The "James Watt" Anniversary Dinner.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Students Section).—Paper, "The Testing of Iron," Mr. J. S. Nicholson, B.Sc., 8 p.m.

BATTERSEA POLYTECHNIC.—Battersea Park-road. "Illumination and its Measurement," by Mr. J. S. Dow, 7.30 p.m.

SATURDAY, JANUARY 20.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the works of the Western Electric Company, Ltd., Woolwich; train leaves Fenchurch-street at 8.53 a.m.

TUESDAY, JANUARY 23.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students Section).—Paper, "Electricity in Mines," Mr. J. Parkinson, 7.30 p.m.

FRIDAY, JANUARY 26.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Paper, "The Knight Sleeve-valve Engine," Mr. J. O. Ruscoe. Chairman, Mr. E. B. Ware.

NEW TELEPHONE NUMBERS.

If members of the electrical and allied industries whose telephone numbers have been changed owing to the transfer of the National Company's system to the Post Office will be good enough to communicate with us, we shall have pleasure in notifying the new numbers and exchanges in these columns in order to facilitate communication.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.

The Annual Smoking Concert of this Association will be held at the Holborn Restaurant, Council Room, on Friday, January 19, at 8.30 p.m. sharp. Mr. H. H. Perry, M.I.E.E., President, in the chair. Tickets and all particulars may be obtained from the honorary secretary, Faraday House, Southampton-row, London, W.C.

Owing to the dinner of the Institution of Electrical Engineers having been arranged for the night originally fixed for the sixth annual dinner of the West Ham Corporation Electric Supply, namely February 1, the committee have decided to postpone the dinner until Thursday, February 22.

TECHNICAL.

NORTHAMPTON POLYTECHNIC INSTITUTE,

St. John Street, Clerkenwell, E.C.

ADVANCED LECTURES IN ILLUMINATING ENGINEERING.

A course of 10 lectures on Illuminating Engineering will be held on Tuesday evenings, at 7.30 p.m., commencing on the 16th January, 1912. Each lecture will be given by a specialist and will deal with the principles and practical problems of the particular subject. The lectures will be adapted to a general technical audience. The following are the short titles of the different lectures:—

The Nature of Light and of Radiation.
Photometry and the Measurement of Light.
The Production of Electric Light and its Distribution.
The Chemistry of Gas Manufacture and Lighting.
The Use of Shades and Reflectors.
Physiological Factors in Illumination.
The Practical Use of Arc Lamps.
The Practical Use of Metallic Filament Glow Lamps.
The Practical Use of Gas Lamps.

Fees:— Single lecture, 2s. 6d. per lecture.
Full Course { Members, 10s. / Non-members, 15s.

Further particulars can be obtained on application at the Polytechnic, or by letter addressed to

R. MULLINEUX WALMSLEY, D.Sc.,
Principal.

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Weekly Digest of Electrical Patents.

Specially compiled for "ElectricalE ngineer."

Carrying Brushes for Electric Machines.

27205—1910. Electric Construction Company, Ltd., New Broad-street, E.C. The brush is pressed against the commutator by a primary spring, which acts through the medium of a secondary spring acting in combination with means for conveying currents to the brush without any portion passing through the holder.

Electric Current Generator.

28611—1910. A. E. R. Bottone, Wallington. The cut out device of this generator consists of an armature which is partly rotated by the magnetic flux of the generator fields between pole pieces magnetically connected to the generator pole pieces against the resistance of a spring and a make and break device operated by the armature.

Current Controlling Device.

178—1911. General Electric Company. Two main controlling devices are connected in series. A signal is connected in an auxiliary circuit and actuated by the closing of the circuit. Two control switches are connected in series in the signalling circuit, one of which, is automatically closed by the opening of one of the main devices to operate the signalling device while the other is automatically opened by the opening of the other main device.

Current Collector for Electrically Propelled Vehicles.

2889—1911. E. M. Munro, Finsbury Pavement House, E.C. The collector consists of a pilot member which enters the groove of the rail. One or more contact making members are mounted on a frame pivotally connected the pilot member which they follow in the groove of the rail.

Switches and Controllers.

5856—1911. E. Garside, Skerne works, Darlington. In order renewals to be simply affected and to simplify the construction of the switch one end of the contact piece is provided with a central abutment and turned down so that shoulders are formed which abut against the face of the insulating base. The other end of the contact piece has a hole through which a screw is passed to secure it to the insulating base.

Controlling Electrically Operated Switches.

6663—1911. General Electric Company. This system comprises a number of contactors which are intended to operate in succession to effect certain connections with the power circuit. Auxiliary switches co-operate with certain of the contacts and are arranged to control the operation of a succeeding contactor.

Speed Control of Electric Motors.

8591—1911. Siemens Bros. Dynamo Works, Ltd., Westminster. This is a controller for effecting the speed control of a pair of motors when they are in series or parallel connection by shunting or cutting out sections of the field windings of the motors and for effecting electrical braking by connecting the two machines as generators.

Maintaining Constant speed in Direct Current Motors.

10342—1911. Siemens, Schuckertwerke, G.m.b.H. Berlin. An auxiliary machine, is coupled with the motor in such a manner that the speeds of the two machines vary in the same ratio. The auxiliary machine is connected in series with an auxiliary field winding distinct from the main field winding of the motor, so that the speed of the motor is automatically maintained at a predetermined and uniform value.

Railway Points and Signals.

18293—1911. Siemens and Halske, A.G. Berlin. The two leads of the supervisory magnet which convey the supervisory current are connected directly to the switches operated by the motor instead of to connections in the signal box.

Electric Railway Signals.

18776—1911. Siemens and Halske, A.G. Berlin. A magnetic switch is actuated by the current in the coupling circuit in such a manner that if the coupling current flows in the right direction through the circuit the line clear circuit is connected to the current source but if the coupling current flows in the wrong direction or entirely interrupted the line clear circuit is disconnected the danger circuit is connected to the current source.

Automatic Reversing Starters for Electric Motors.

23757—1910. J. Hofle, 8, Furz-utcza, Budapest. This reversing switch, resistance switch and main switch or circuit breaker are mechanically connected together in series alongside each other and act successively in starting and stopping so that the motor can only be started with the entire series of stopping resistance in circuit is not broken either at the change over switch or at the resistance switch, but only at the main switch or series circuit breaker. Consequently the attendant has only to observe this one point as no spark occurs at the others.

High Frequency Electric Apparatus.

24143—1910. M. Sanchez, 63, Thirteenth Avenue, Newark, U.S.A. According to this invention the current is applied to the capacity and the interrupter independently of the primary of the transformer. The charging circuit including the condenser or capacity and the coil of the interruptor is separate from the oscillatory or discharge circuit which includes the primary of the transformer, the condenser and the contacts of the interruptor. The relative values of the inductance and capacity enter into the discharge circuit and are adjusted to obtain a highly oscillatory effect.

Insulating Fittings for Overhead Traction.

24475—1910. E. M. Munro and the Railless Traction, Company, 56, Moorgate-street, E.C. This fitting comprises two portions, one of the solid strip type and the other of the multiple air gap type and are connected by an intermediate metal member. They are specially adapted for use at crossings.

Incandescent Electric Lamps.

27401—1910. S. Horrath, 51, Standen-road, Southfields. The filament length is supported in the lamps by means of links mounted on the supporting arms radiating from a central stem. The links may be circular, oval, endless or spiral

Tempory Lamp Holders.

3748—1911. W. Leonard, 4, Soho-street, W. This lamp holder has a fixing plate secured to it. The plate is movable, relatively to the lamp in order to facilitate, the fastening of the lamp in any position.

Controlling the Speed of Alternating Current Motors.

4627—1911. A. Heyland, 11, Boulevard du Regent, Brussels. An auxiliary device is provided which operates as a frequency charger. One member is connected to the secondary winding of the main motor. The other member is connected to the mains. The device is driven in an adjustable manner.

Electric Conductors.

5569—1911. Gesellschaft fur Elektrotechnische m.b.H. 88, Belle-Alliancestrasse, Berlin. Aluminium and other current conducting wires are drawn through an electrolyte at a high current density in order to produce a thermal effect on the surface of the wire.

Electric Arc Lamps.

14127—1911. Siemens Schuckertwerke, G.m.b.H. Berlin. The electrodes of the lamp have rims which overhang their projecting tips and cause eddies in the ascending gases thus preventing the arc from climbing.

Controlling Electric switches from a Distance.

14704—1911. J. L. Odgers, 1, Tank-square, South Jamalpur, India. This device comprises a drum like member which may be successively part rotated in one direction by a cord or chain to impart movement in opposite directions to a slidable bar connected to the switch. Means are also provided for the returning drum to initial position and for limiting the movement.

Dynamo Electric Generators.

20904—1911. G. Inroy, Gt. Eastern House, Bishopsgate, E.C. The poles of the generator are tapered or of wedge shapes cross section and bored out to receive a cone shaped armature. The amature is controlled by a ball governor fitted inside the dynamo casing and attached direct to the armature working. The air gap may be varied.

Current Transformer for High Voltages.

17208—1911. Siemens and Halske, A. G. Berlin, S.W. The primary circuit is surrounded by two insulating cylinders which may be stepped down in known manner, arranged side by side. One of the cylinders is surrounded by a ring shaped iron core which carries the secondary winding.

Electric Arc Lamps.

22841—1910. Gesellschaft fur Maschinen und Metall-Industrie m.b.H. 103, Leipzigerstrasse, Berlin. This is an improvement in lamps in which the electrodes are moved laterally towards each other and fed downwards by the intermittent raising of a clamp.

Operating Selections in Automatic Telephone Exchanges.

26079—1910. Telephon Apparat Fabrik, E. Zwietusch & Company, G.m.b.H. The current impulses sent out from the sending station are first received in a registering device which may be easily operated and which with other similar devices is arranged at the exchange in percentage to the number of sending lines.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.					Receipts per			Cost per car mile
	Ending	1911-12.	1910-11.	Week.	Current year.	1911.	1910.	Ending	Total receipts.	Passengers carried.	Car miles run.	Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Jan. 27	1,827	1,702	+ 124	+ 2,639	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5· 8
Ayr Corporation	Aug. 12	550	572	— 22	—	8	8	—	—	—	—	—	—	—	—
Birkenhead Corporation	Jan. 7	1,182	1,064	+ 118	+ 1,656	24·089	24·089	Mar 31	56,713	12,544,501	1,207,761	1·089	11·13	2,315	6·74
Birmingham Corporation	Dec. 30	10,376	7,893	+ 2,483	+ 68,378	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Aug. 23	1,304	1,002	+ 302	+ 2,392	14·62	—	Mar. 25	58,367	10,310,965	1,041,021	1·27	12·60	3,915	8 36
Blackpool Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Jan. 6	350	295	+ 54	— 4	—	—	Dec. 31	35,210	2,939,144	592,312	—	—	—	—
Bolton Corporation	Jan. 7	2,910	2,787	+ 123	+ 6,124	46	42	Mar. 31	121,707	27,018,149	2,641,292	1·08	11·05	2,897	6·58
Bournemouth Corporation	Jan. 7	1,712	1,436	+ 276	+ 20	30	21·95	„ 31	89,695	14,686,368	1,782,706	1·46	12·07	3,066	7·76
Bradford Corporation	Aug. 5	5 573	5,706	— 133	+ 8,201	100	54·81	—	—	—	—	—	—	—	—
Brighton Corporation	Jan. 7	838	754	+ 84	+ 2,377	9·5	—	„ 31	49,124	10,708,184	1,126,676	1·101	10·464	2,857	—
Bristol Tramway Company	Jan. 5	6,569	5,680	+ 889	+ 6,569	57	57	Dec. 31	308,615	47,454,560	5,914,713	—	—	—	—
Burnley Corporation	Jan. 6	1,508	1,359	+ 149	—	22	22	Mar. 31	65,295	12,911,113	1,263,118	1·21	12·41	6,067	7·89
Burton Corporation	Jan 7	284	267	+ 17	+ 585	10	6⅔	„ 31	15,368	3,131,172	432,911	1·07	7·75	1,416	6·41
Cardiff Corporation	Dec. 30	2,348	2,368	— 20	+ 6,963	17·35	17·35	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Central London Railway	Jan. 6	5,044	5,705	+ 661	—	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,780	2·01	5·769	55,404	30·27a
City and South London Railway	Jan. 7	3,435	3,687	— 252	— 252	7·26	7·26	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Jan. 4	261	289	— 28	+ 593	9·89	9 89	Dec. 31	25,497	5,704,071	899,173	1.07	6·80	2,578	—
Croydon Corporation	29	1,943	1,877	+ 66	+ 4,821	11⅛	—	Mar. 31	85,806	19,476,576	2,269,500	1·057	9·07	4,428	—
Darwen Corporation	Dec —	—	—	—	—	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Dec. 30	204	204	—	+ 1,393	7	7	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Jan. 5	77	88	— 11	— 11	7	7	Dec 31	7,472	449,677	146.081	4·0	12·27	1,067	8·38
Dublin U.T.	Jan. 5	4,104	3,750	+ 353	+ 435	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	July 19	1,238	1,210	+ 28	— 83	28	—	May 15	62,328	16,843,900	1,322,894	·87	11·30	—	7·28
East Ham Corporation	Jan. 6	1,101	996	+ 105	+ 2,453	15	14	Mar. 31	53,287	16,059,912	1,303,753	·78	9·81	3,750	7·57
Glasgow Corporation	Jan. 6	20,912	20,666	+ 246	+ 37,897	196	195½	May 31	893,591	222,730,571	20,974,016	·96	10·22	4,706	5·75
Gloucester Corporation	—	—	—	—	—	15	—	—	—	—	—	—	—	—	—
Halifax Corporation	Sept. 5	2,186	1,954	+ 232	+ 5,375	37·171	37	Mar. 31	92,609	17,067,856	1,909, 97	1·30	11·64	2,456	—
Huddersfield Corporation	A g. 19	2.298	1,965	+ 300	+ 4,324	29	28½	„ 31	96,185	19,001,660	2,058,663	1·22	11·21	3,375	6·31
Hull Corporation	Jan. 6	3,098	2,952	+ 145	+ 6,372	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Sept. 2	545	526	+ 19	+ 5	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Jan. 3	119	111	+ 8	+ 97	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Jan. 3	1,531	1,515	+ 16	+ 2,255	39	39	Dec. 31	68,689	13,755,329	2,272,765	—	—	—	—
Leeds Corporation	Sept. 9	7,689	7,174	+ 51	+ 12,730	108	108	Mar. 31	357,610	78,385,015	8,152,990	1·08	10·41	3,311	5·42
Leicester Corporation	Jan. 6	2,504	2,276	+ 228	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Dec. 30	12,052	11,610	+ 442	+ 18 951	116	109	Dec. 31	582,276	125,507,283	12,235,408	1·106	11·42	5,020	7·655
Liverpool Overhead Railway	Jan. 7	1,528	1,451	+ 77	+ 2,342	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Dec. 27	45,862	45,192	+ 670	+ 86,891	13⅜	133½	Mar. 31	1,891,035	418,317,377	39,545,512	1·06	11·48	—	6·42
London Electric Railway	July —	60,847	58,978	+ 1,208	—	21·25	21·25	—	—	—	—	—	—	—	—
Lowestoft Corporation	Jan. 6	155	153	+ 2	+ 40	3½	—	Sept. 30	10,896	2,377,316	329,958	1·07	7·9	2,179	6·82
Maidstone Corporation	Mar. 6	157	100	+ 7	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Jan. 6	16,524	15,896	+ 628	+ 34,128	183	183	Mar. 1	810,094	165,800,077	17,367,200	1·16	11·19	4,667	7·17
Metropolitan District Railway	Jan. 6	12,535	12,105	+ 430	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Dec. 31	18,136	17,909	+ 227	— 3,674	24½	24½	Dec. 31	718,089	102,849,458	—	1·48	—	—	—
Nelson Corporation	Jan. 6	160	139	+ 21	+ 1 526	2½	2½	Mar. 31	7,576	2,118,878	203,708	—	8·93	—	—
Newcastle-on-Tyne Corporation	Jan. 6	4,346	4,091	+ 255	+ 13,820	60½	59½	„ 31	206,130	45,335,207	4,437,639	1·09	11·15	3,421	—
Newport (Mon.) Corporation	Dec 30	726	787	— 61	+ 944	14½	14½	„ 31	35,146	8,452,562	895,238	·99	9·42	2,425	—
Oldham Corporation	Aug. 13	2,137	1,886	+ 227	+ 2,543	36⅛	35	„ 25	97,842	19,125,202	1,893,777	1·15	12·399	2,653	8·817
Portsmouth Corporation	April 29	1,788	1,783	+ 5	— 1,240	15½	28½	Mar. 31	102,978	23,053,717	2,291,767	1·10	10·15	—	—
Reading Corporation	April 27	570	556	+ 13	+ 171	13½	13½	„ 31	32,506	7,834,575	909,439	·96	8·28	4,183	6·98
Rochdale Corporation	Sept. 9	1,539	1,296	+ 243	+ 4,823	27	20·93	„ 31	63,000	11,360,871	1,402,532	1·31	10·774	—	—
Rotherham Corporation	Aug. 31	655[1]	645	+ 10	+ 1,412	12	9·39	„ 31	33,313	6,960,178	722,393	—	11·06	—	—
Salford Corporation	Sept. 4	4,872	4,907	— 37	+ 6,056	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	April 23	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Jan. 7	6,813	6,189	+ 624	+ 17,326	40	40	Mar. 25	316,739	84,500,331	7,618,383	·900	9·978	4,144	—
Southampton Corporation	Aug. 16	1,471	1,281	+ 190	+ 3,372	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 2	980	1,253	— 273	+ 1,489	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,880	4·75
Sunderland Corporation	Aug. 6	1,594	1,553	+ 41	+ 3,128	20	20	„ 31	58,889	14,561,672	1,451,906	·97	9·73	2,944	—
Swindon Corporation	Nov. 8	155	138	+ 17	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	—	—	—	—	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey Corporation	Jan. 6	1,111	953	+ 158	+ 5,921	12·68	12·45	Mar. 31	49,835	9,990,653	1,059,629	1·19	11·28	3,971	—
Warrington Corporation	Dec. 28	498	465	+ 33	+ 476	9½	9·656	„ 31	20,169	5,206,980	435,774	·915	10·939	2,064	6·281
West Ham Corporation	Mar 28	2,445	2,250	+ 195	—	27·8	27·8	Mar. 31	127,066	36,846,649	2,007,805	·801	10·21	4,518	7·22
Wolverhampton Corporation	Aug. 23	986	917	+ 69	+ 1,416	25	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6.509

a Train Miles. [1] Half-years' figures.

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Metallic Seamless Tube Co., Wiggin-street, Birmingham.

Electric Fans.
Edison & Swan United Electric Co., 36 & 37, Queen-street, Cheapside.
General Electric Co., 71, Queen Victoria street.
Gibbs, J. & Son, 72-76, Duke-street, Liverpool.

Electric Heaters.
British Prometheus Co., Ltd., Salop-street. Works, Highgate, Birmingham.
Bastian Electric Heating Syndicate, Ltd., 91-93, Palmerston House, E.C.

Electric Light Contractors.
British Thomson-Houston Co., Rugby.
Ferranti Limited, Hollinwood, Lanca
Hooper's Telegraph & Indiarubber Works, 31, Lombard-st., E.C., & Millwall Docks.
Johnson & Phillips, Old Charlton, Kent.

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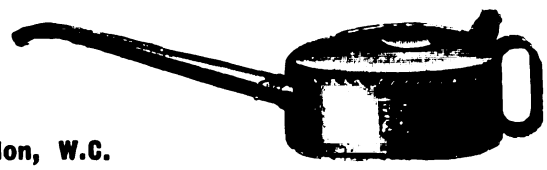

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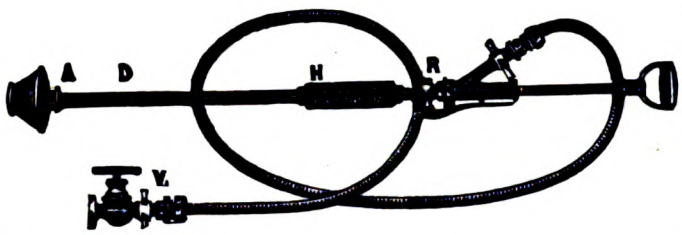

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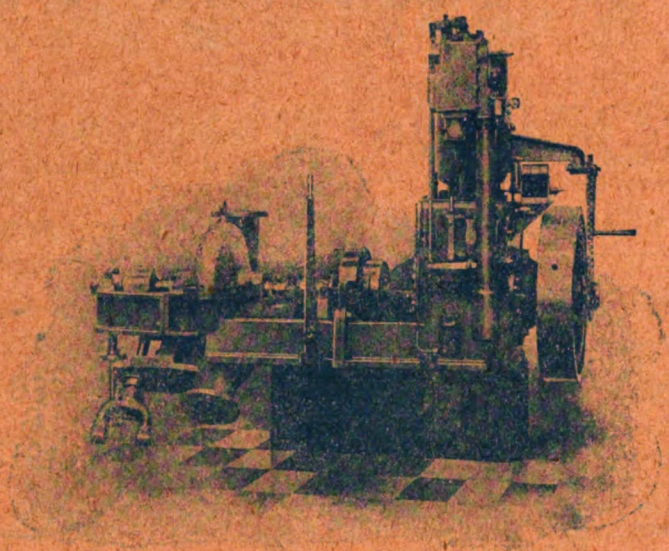

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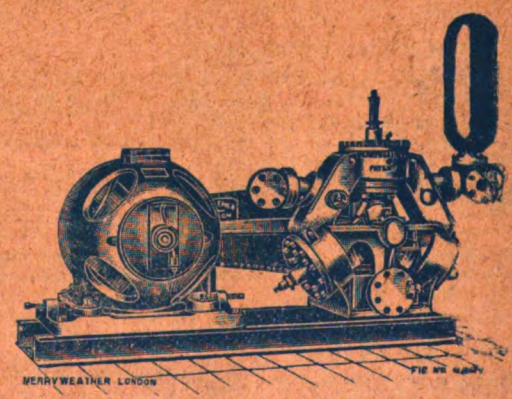

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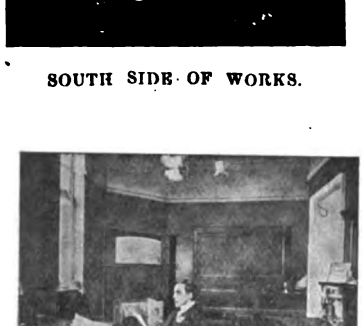

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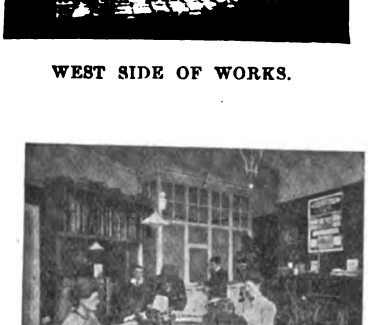

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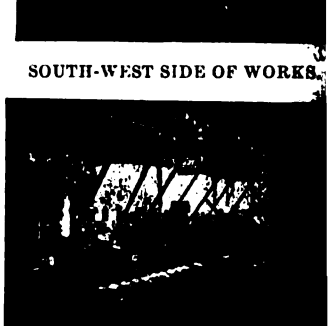

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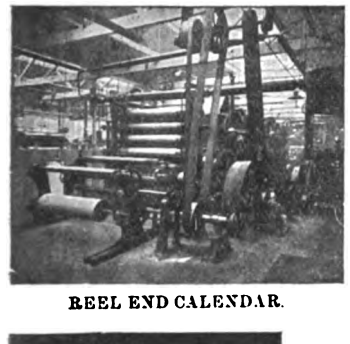

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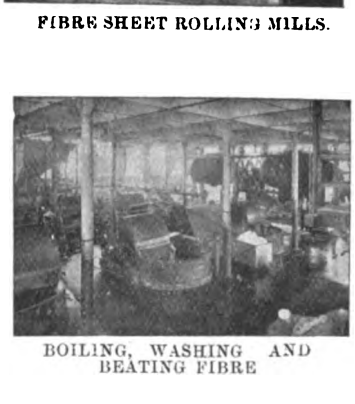

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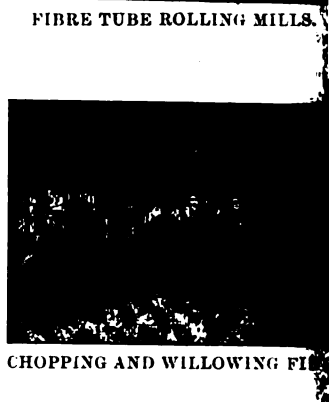

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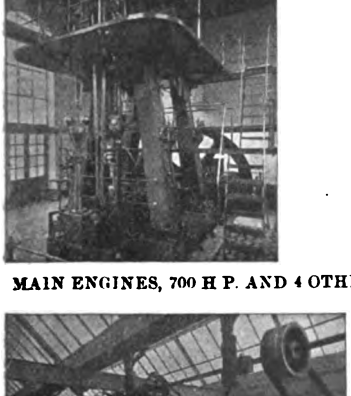

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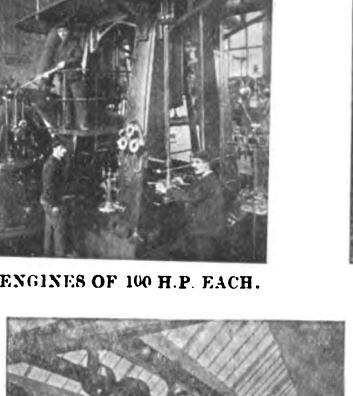

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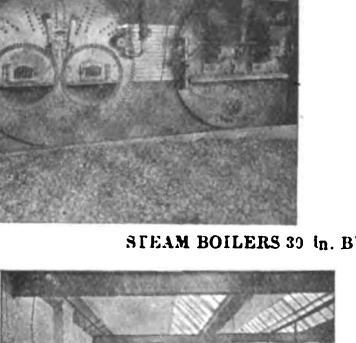

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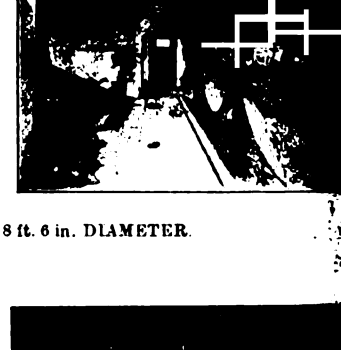

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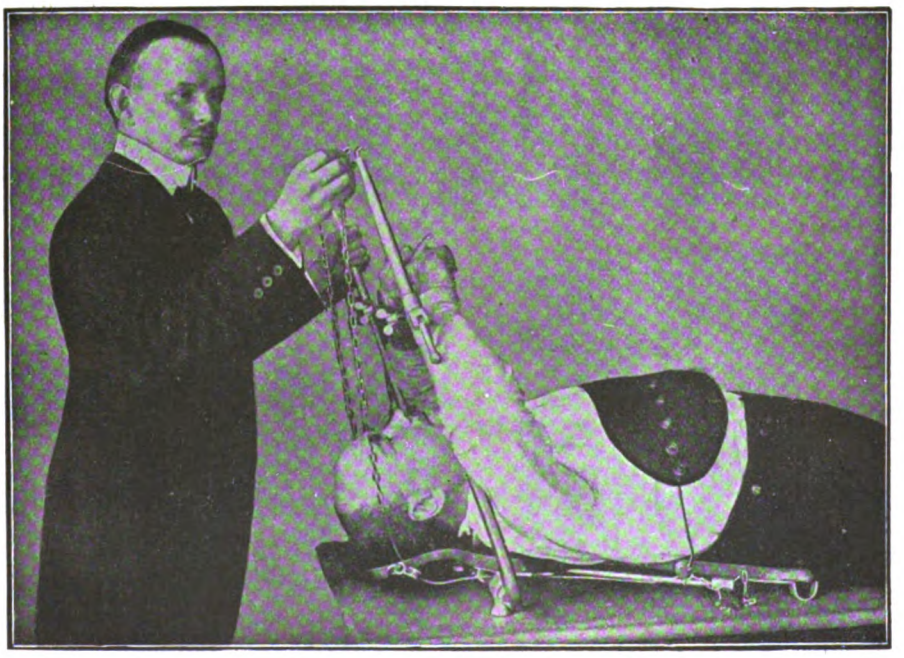

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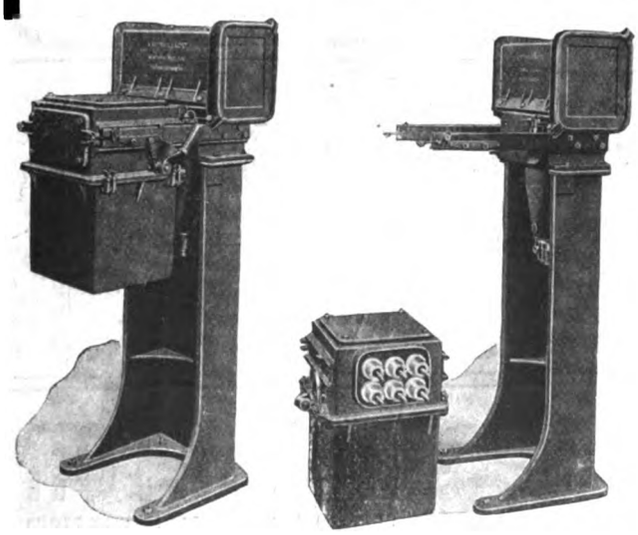

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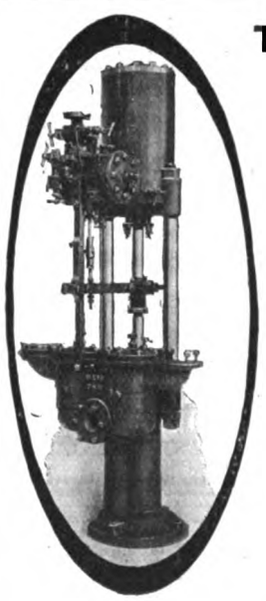

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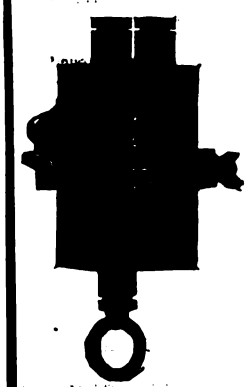

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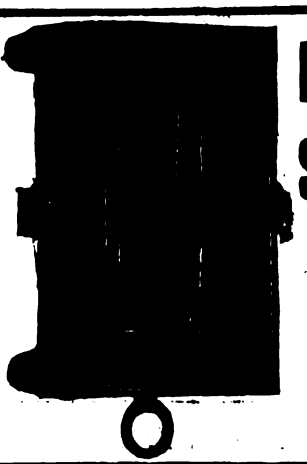

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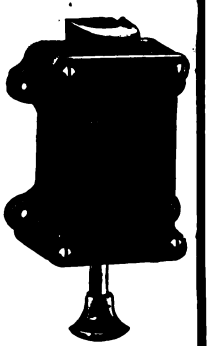

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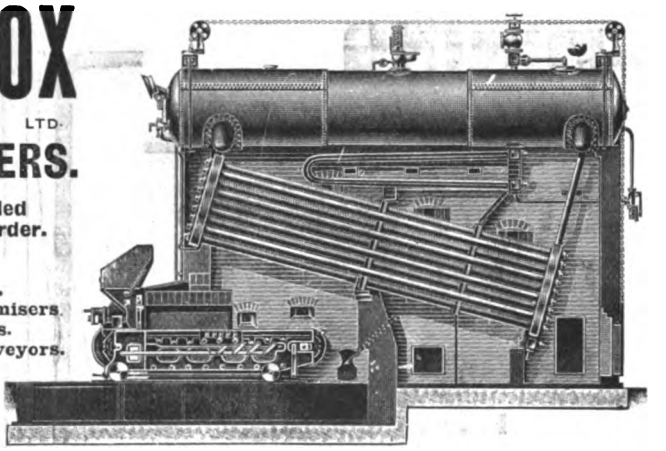

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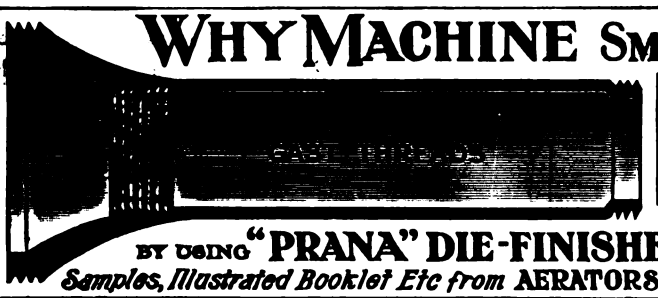

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NOTES.

WHO were the first Electrical Engineers? Dr. Paul Mottelay—whose recovery from his prolonged illness is a source of keen gratification to his many distinguished friends in the Electrical world—has been telling in our columns the story of the Father of Electrical Science, William Gilbert, of Colchester, and of all those philosophers and others mentioned by him in "De Magnete," but the tale of the first electrical engineers still remains to be told. Or should we rather say, did remain to be told until Charles L. Benjamin, of the world-famed Cutler-Hammer Manufacturing Company, of Milwaukee, started out on the trail? At any rate, among our New Year's Gifts there comes (a little belated owing to the occasional eccentricities of the mail service) a seasonable Greeting to Electrical Men, bearing the title of "Our Ancient Lineage," in which he essays to fill this lamentable gap in the history of scientific evolution. And this is the way he puts it:—

If you want to know who were the first electrical engineers,
You must go back in history for years, and years, and years;
Back of the Roman Empire, back of the siege of Troy,
Back of the time when Methuselah was a snivelling little boy.
Now first I shall speak of Noah, and this is my excuse,
He was the earliest victim of an overload of juice;
Ham stumbled across him late one night when Noah was stiff and stark.
And from this we know that long ago they had blow-outs on the ark.
Then I might mention Moses, a tall and wiry cuss,
He was the first conductor, for he led the Exodus;
The Egyptians made resistance, but Pharaoh's hosts were fooled,
And one and all, as you may recall, were thoroughly water-cooled.
Then there's the sly old Serpent that in the Garden lay,
He was the first to wind a coil and there was hell to pay;
He led both Adam and Eve astray, and this it was, in brief,
That led to the invention of the laminated leaf.
If you want to know who were the first electrical engineers,
You must go back in history for years, and years, and years;
Back of the tombs of Egypt, back of the temple of Pan,
To the day when the virgin Earth gave birth to the first of the race of man.

We have yet to learn how Dr. Mottelay will regard this dethronement of Gilbert of Colchester, but all the same we take off our hats to Mr. Benjamin. May he, and the Cutler-Hammer Company, and the well-known co-operating firm in this company (in the composition of which there is also a suggestion of Adam) live long and flourish!

THOSE who followed (some of them, it is to be feared, with aching hearts) the recent correspondence in our columns which bore the heading "Are there Too Many Electrical Engineers?" may take heart of grace from some recent utterances of Mr. Theodore N. Vail, the president of the American Telephone and Telegraph Company. Mr. Vail, controller, in effect, of practically all the telephone lines in the United States, has vacant thirty positions carrying salaries of £2,000 to £5,000 a year, and is, metaphorically speaking, heart-broken because he cannot fill them. As to why these fine appointments are going begging, Mr. Vail has theories which, if not convincing, are, at any rate, interesting. The reason is found in "the everlasting feeling of men as to 'Where do I come in?'"

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Mr. Vail's theory being that, looking continually in that direction, these men have their own interests at heart more than the work on which they are engaged. "Several times," he says, "I have made promotions and mistakes on account of just this reason. There are some men who can never get the personal element out of their advancement, and therefore do not advance accordingly. The man who would reach the high place must let the place seek him, and not be everlastingly seeking for the place himself. He should remain right in the confines of his own job, and do his work there better than anyone ever has done it before. I should say the perpetual consideration as to where the individual comes in has kept more men back than any other, for it is only a question of time when they plunge, in the hope of getting in, and cannot swim back to safety and success. Responsibility gravitates to the man who can shoulder it, as Stevenson says, and the high salary gravitates with it. The man who does not create the big situations cannot hope to step in and carry them through. The great thing is to create a big business situation—and the big situation will then create him, accordingly."

EXPOUNDING this theory, Mr. Vail pronounces the dictum that the lack of advancement for the majority of men who could to-day fill these vacant places and command these coveted salaries is due to their misguided idea that the mere efflux of time must necessarily carry advancement with it, independent of special effort. But he says "long service does not necessarily mean promotion. While it is commendable that a man can stick to work which is given him, the men who occupy the first places are those who not only do that which they find in the actual service, but improve on that service, make it better, create a new standard in that particular field. The great demand is for the man who can take some of the responsibilities away from the man just above him. There are many big business enterprises to-day whose everlasting problem is to get this kind of men, and they will pay—and pay well. Production in order to be profitable must eliminate waste. Therefore the man in any position who can work it up to such a perfected degree that he eliminates waste and brings profits accordingly, better than ever before in his particular department—such a man cannot be held down. His services are sought after. Therefore it is no unusual circumstance for the heads of growing concerns to be continually on the lookout for such men. I would advise every man," adds Mr. Vail, "to show his worth and his superability by actual facts and figures every day, every year. There is no such thing as chance in the matter of progress. In the vernacular, you must 'produce the goods.' The man who understands, and works understandingly, is the one who creates the backbone of the £2,000 product. We want him badly." It will probably not be forgotten that that was the general tenour of more than one of the letters published in these columns during the progress of the correspondence referred to, so that it is evident that the pinch has been felt on this as well as on Mr. Theodore Vail's side of the Atlantic. But what the American Telephone Company is seeking is not merely an electrical engineer, or a telephone expert or a commercial manager, but all or any of these plus a temperament; and the atmosphere of England, unfortunately, is not the kind which produces the temperament required. It tends rather to the generation of the "dinner-bell" genus—the 9 o'clock to 6 o'clock men whose hats are on for lunch at five minutes to one and who are out in the street and on the way home before the clocks have finished striking six.

WE mentioned in our issue of December 1, the fact that the Anderson Electric Car Company of Detroit, would begin in the spring of this year to place electric motor cars on the English and French markets. We now learn from the "Automotor Journal" that Mr. John F. Monnot, who is very well-known both in London and Paris as an able electrical engineer, has been invested with the selling rights for the Edison storage batteries and for the product of Mr. W. C. Anderson's factory at Detroit.

THE great transport combine, first outlined in the ELECTRICAL ENGINEER nearly twelve months ago, has arrived at such a stage towards actual accomplishment that in the course of a few days a meeting is to be held of the Underground Electric Railways of London to consider a resolution to enable the company to carry on business "as proprietors and manufacturers of and dealers in omnibuses, cabs, and public and private conveyances and vehicles of every description, whether propelled or drawn by steam, gas, oil, electricity, or other mechanical power, or by animal traction, and as general carriers; also to be allowed to acquire, by purchase or otherwise, controlling or other interests in any stocks, shares, or securities of any company carrying on such business." The through-ticket system will be an essential feature of the arrangement should the great merger be successfully carried out. Meanwhile a grain or two of salt may be recommended as a desirable addition to the statements which have appeared in some of the lay newspapers purporting to give authentic details of the whole scheme. It will certainly not be brought to fruition without the full co-operation of the London General Omnibus Company, and at last week's meeting of that Company, Colonel Colvile made it very clear that nothing would be done without the acquiescence of the shareholders.

AT that meeting, by the way, the Chairman, like another (shall we say) even better known personage, was moved to express his wonder as to "how these things get into the papers." Almost simultaneously a statement "got into the papers" to the effect that the Central Telegraph Office was proposing to reduce the strength of the special telegraph staff on duty from 5 p.m. to 1.45 a.m., and that the places would be filled by operators drawn from all parts of the office, who may or may not be acquainted with the handling of this class of work, and whose duties will be from 4 p.m. to midnight. It is true that certain changes are proposed, but there is, we are officially assured, no warrant whatever for the inferences drawn. These operators deal exclusively with press telegrams and to the extent of about seventy men, are supplementary to the ordinary evening staff, whose duties terminate at various hours up to a little before midnight. Since Parliament took to rising at eleven o'clock many of these operators have been superfluous, while in regard to others the proposal is to replace them, not in the casual manner suggested, but by selected and efficient operators thoroughly competent to perform this class of work. But up to midnight, by which hour the heaviest work is over, the proposal is not only not to reduce the staff, but to augment it, and make the conditions easier all round. As we have ourselves in the past criticised the methods of the Telegraph Department, it is only fair that we should put this explanation on record, though none of the statements now contradicted were made in our pages.

WE are glad to note that Mr. D. N. Dunlop, the new Secretary to the British Electrical and Allied Manufacturers Association, has come promptly forward with a protest against certain statements published in the Newcastle papers by Mr. T. Good in regard to electricity in mines. There is no doubt, unhappily, that after a marked decrease in the number of accidents in mines during the period from 1896 to 1906, the current decennial period threatens to show a decided increase. But there is, as Mr. Dunlop is keen to point out, no justification for Mr. Good's assumption that this tendency is due to an increased use of electricity. Mr. Good's reasoning, says Mr. Dunlop, is fallacious: for instance, "It is a fact," he says, "that in the country where most electricity is employed—the United States—there they kill the most miners." But it is also a fact, Mr. Dunlop points out

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that on those American railroads where no electricity whatever is employed, they kill most passengers and railway servants. Are we to blame the steam locomotive for this? "Then," says Mr. Dunlop, "Mr. Good gives us a harrowing hypothesis about the death of horses in a mine, which might have been men, only that they happened to be horses; and he ends with the usual alarmist statement that electricity is 'profoundly dangerous.' Exactly the same thing has been said, and may still be said, of gunpowder, ordinary household gas, the motor-car, various chemical compounds, and what not; but the fact does not prevent the properly-regulated use of any of these things." In conclusion, Mr. Dunlop quotes some of the findings of the recent Departmental Committee (Electricity in Mines):—

"The feeling against the use of electricity in mines is largely based upon a vague fear due to lack of knowledge. Experience has shown that the proper use of electricity cannot be regarded as inherently unsafe. . . . The number of fatal accidents due to the use of electricity in mines in any one year has never reached a figure greater than 1·54 per cent. of the total number of fatal accidents in mines."

WE have great pleasure in calling attention to a notification in another column announcing that the Central Technical College Old Students' Association has arranged to hold a dinner in honour of Professor W. C. Unwin, F.R.S., in celebration of his election as President of the Institution of Civil Engineers. The dinner will be held at the Criterion on the second Saturday in February, under the Chairmanship of Mr. W. Duddell, F.R.S., the President of the Old Students' Association, and all old students, whether members of the Association or not, and also all Professor Unwin's Cooper's Hill students, will, we are asked to say, be cordially welcomed.

THERE can be no doubt about the existence of a very widespread and healthy optimism in regard to the outlook for the electrical industry. The latest testimony is from the usually very well-informed trade correspondent of the "Financier," who declares that it is a long time since the electrical industry was in so active a condition in this country, or had such bright prospects. This arises, as was pointed out by us last week, partly from the renewed attempts and achievements in connection with railway traction, and partly in the application of electric motors for power distributing purposes in numberless trades where they now take the place of a number of small steam engines. Apart from this, the electric supply companies have recovered from the state of depression caused by the introduction of the metal filament lamp, the consequent economy of current and the stoppage of additional installations, and all this means further activity. The "Financier" adds that in no department of electric work is there more scope, and perhaps there is none which has been more neglected, than that in connection with auxiliary machinery on board ship. "It is a vast field for enterprise, and when the system is made the most of in this respect important economies will be effected in the working of every description of cargo vessel." With regard to British-built motors, the demand, says our contemporary, has not only increased rapidly in the British Isles, but in all parts of the Empire, and in most parts of the world. The financial results of the year's work have been exceedingly satisfactory, and at the present time one of the principal difficulties which trade has to contend with is the tendency among many of the leading builders to get in arrears with the execution of their orders.

ONE learns with a sense of considerable relief that the charges made against the War Office some three months ago by Mr. Grindell Matthews, the inventor of a new system of wireless telephony, have proved, on complete investigation, to be groundless. Mr. Matthews had been asked by the Secretary for War to give a demonstration of his system, and had been assured (though not apparently by the War Department) that the demonstration was to be a strictly private one, and when he found a body of experts taking notes and making sketches he felt very much aggrieved, inasmuch as his invention was entirely unprotected. When subsequently he found that his apparatus had been seriously damaged while at the War Office, he naturally felt still further aggrieved, and in the heat of the moment made charges against the Department which must have caused grave perturbation in the minds of other inventors. Mr. Grindell Matthews now announces that he is satisfied from the inquiries since made that the War Office had no cognisance of the fact that the demonstration was to vary from the usual routine of the Department, and further, that it was not in any way responsible for the damage done to the apparatus. All imputations are frankly and fully withdrawn, and the matter has come to an entirely amicable conclusion.

IT is rather a curious circumstance that the acquisition by the British Post Office of the National Telephone Company's service should have set the minds of the United States and the Canadian authorities simultaneously to work to achieve much the same end. The American Postmaster-General intends to recommend to Congress the purchase of all the various private telegraph systems in the States, while in the Canadian House of Commons a resolution is to be brought forward for a Commission to consider the purchase and working of the private telephone as well as telegraph systems, and for the construction of trunk line connections in the West. The Canadian resolution is a step towards the nationalisation not only of the telephone system, but of the land and sea cable and wireless services, a policy which the present Government of the Dominion is known to view with strong favour. A dominating factor in this attitude is the great disparity in charges in the Canadian West, which vary in some cases to the extent of upwards of one hundred per cent. for precisely similar services. Mr. Charles Bright has a good many disciples in Canada, and whatever may be the outcome of the proposed Commission, there is no doubt that it will accelerate his ideal of an All-Red Cable in the All-Red land lines to link the Atlantic with the Pacific. So far as the United States proposal is concerned, it is felt that there is little likelihood of its immediate realisation. It will cost, it is estimated, £100,000,000, and there are very strong and very tenacious interests to be fought. Moreover, President Taft is understood to be opposed to the project.

The syndicate promoting an electric railway up the Zugspitze has got its concession. The syndicate includes A. Bliechert & Company, of Leipzig Tohlis, and the Bergmann Elektrizitatsunternchmungen A.G., of Berlin. Starting from Partenkirchen-Graman, the line will become a mountain railway proper at Eibsee, whence a hanging railway will go to the summit. The capital is 5 million marks, with power to increase it.

LONDON ELECTRICAL ENGINEERS.—Officer commanding, Lieut.-Colonel H. M. Leaf. The following orders have been issued for the current week:—Monday, January 22—"A" Company: Technical work, musketry instruction (standard tests), 7 to 10 p.m. Tuesday, January 23—"B" Company: Technical work, musketry instruction (standard tests), 7 to 10 p.m. Thursday, January 25—"C" Company: Technical work, musketry instruction (standard tests), 7 to 10 p.m. Friday, January 26—"D" Company: Technical work, musketry instruction (standard tests), 7 to 10 p.m. Saturday, January 27—Headquarters will be opened for regimental business from 10 to 12 noon.—(Signed) P. H. S. Campbell, Captain R.E. and Adjutant for O.C. London Electrical Engineres.

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The Evolution of Electrical Publicity.

SECOND ARTICLE.

FIG. 1.

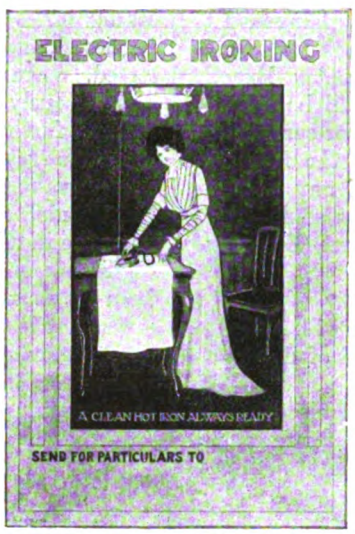

FIG. 2.

FIG. 3.

Continuing our story of the Evolution of Electrical Publicity, we come now to the work of the Electric Supply Publicity Committee, one of the chief aims of which is the production of high class literature suitable for distribution by electric supply undertakings.

Until the formation of the Publicity Committee, the literature issued by the undertakings as a whole was certainly not above criticism. We are speaking, of course, of the 500 odd undertakings in the United Kingdom as a whole. For some considerable time certain supply companies had issued quite first class circulars, pamphlets, booklets etc., but they were quite individual efforts on the part of these companies and due to their having available the competent assistance necessary. It is out of the question, of course, with very many undertakings, especially those of a small size, to be able to get out individually the literature suitable. On the other hand, they certainly would not wish, even if it were possible, merely to copy the publications of the larger companies mentioned.

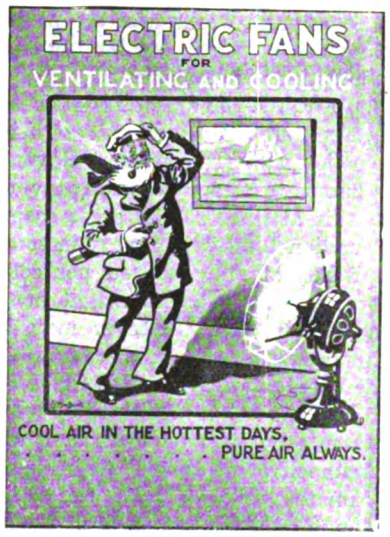

FIG. 4.

The obvious way out of the difficulty was for them to form a committee, of which they would become members, in order to get out in the common interest all the circulars, posters, showcards, etc., necessary.

FIG. 5.

The advantages of such co-operation are almost too obvious to mention. The chief is the question of price, since small undertakings could be supplied at quite a low figure, and a large variety of literature could be available. Also, expensive designs could be obtained from first class artists, which would be altogether out of the question for any undertaking to produce individually for the comparatively small quantity required.

The committee, had, of course, a large field before them. The general scope for circulars may be divided up into

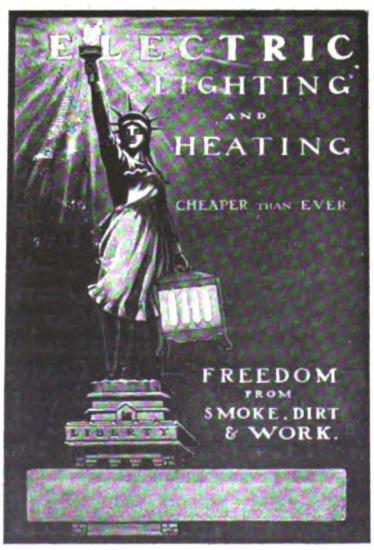

FIG. 6.

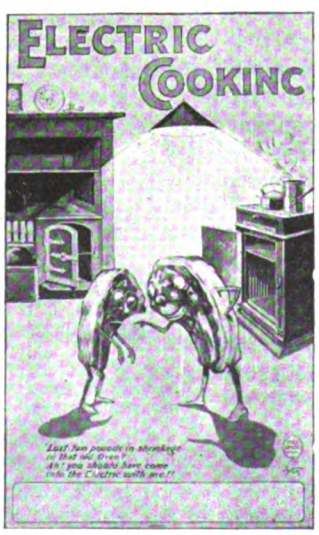

FIG. 7.

FIG. 8.

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lighting, power, heating, cooking, ventilating and sundry domestic and other uses. Since the committee's inauguration, they have covered the entire ground, both by way of posters and also circulars.

The first poster produced was the Lighting poster (Fig. 1). The purpose of this poster was to treat of electric

FIG. 11.

light in its broadest possible sense, with a quite universal application. The idea of universality is carried out in this design, which shows a huge city at night time, flooded with electric light; shops, houses, public buildings, all coming under its direct rays, as in actuality they do.

The second poster was electric ironing (Fig. 2). The scope for design in this is, of course, limited, and is primarily for the conveying of pure information. The poster, therefore, shows a lady ironing, with an attachment to a lampholder, to show that the supply for lighting can be also used for this other purpose straight away.

FIG. 9.

Heating was the next subject tackled. It was thought as a variation, something of a humourous type might be put forward. The design in this case is by Mr. Chas. Crombie. One of the chief selling points about electricity is, of course, its doing away with smoke, dirt and work, and reducing the labour of the house. Mr. Crombie has seized upon this point and given it a humourous application. It shows a maid (caricatured, of course) luxuriating in an arm chair in an ecstasy of idleness. For the reason of this cessation of labours, with a box, broom and pail idle, she points with her thumb to a radiator and exclaims delightedly "That's done it." (Fig. 3.)

FIG. 13.

The ventilating poster came next and shows a good size fan at full blast. To drive home the application of fans the poster shows the breezy and exhilarating effects it has upon an old skipper of jovial aspect, who is caught in its full blast at top speed. The health-giving qualities are paralleled in a small sea picture which shows a ship in a full sou' wester (Fig. 4.)

The next subject was electric power (Fig. 5). In this case, something universal in application was wanted, as the uses to which electric power can be put are too multifarious to be gone into in any single poster. On a preliminary

FIG. 12.

poster it is, of course, impossible to give much detail in regard to advantages of electric power. All that can be done is to stimulate enquiry. This poster would certainly do this by touching on the most susceptible of commercial instincts, that is, the saving of money.

A further poster, combining lighting and heating, has been issued (Fig. 6) and touches on the advantages which are contingent on both of these, namely a freedom from smoke, work and dirt. As an embodiment of this freedom, Mr. Chas. Crombie has taken the statue of Liberty, and, keeping the central idea, has adapted it with striking effect.

FIG. 10.

With regard to cooking, we have just been notified of a new design (Fig. 7). This design is again of a humourous character, and is intended to emphasise the great point about electric cooking, viz., the small shrinkage in meat cooked by electricity, compared with cooking by other methods.

Then as regards pamphlets, leaflets etc., these have covered the same ground and been vary various in character. For instance, there is the one on lighting by Mr. Chas. Crombie (Fig. 8). This is a circular which has become deservedly

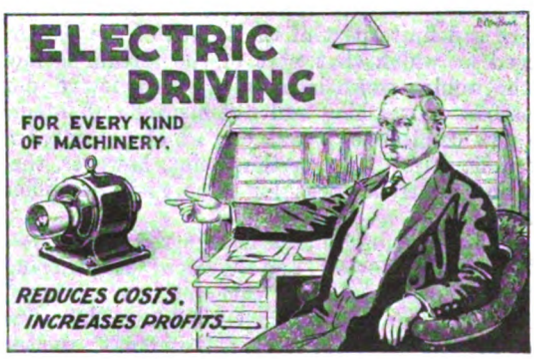

FIG. 14.

popular. The illustration is, of course, merely a tag, but it strikes the key-note of a vigorous and pointed appeal which is carried on by the letterpress throughout the whole circular and is certainly one of the most effective that have ever been produced.

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A circular somewhat similar in treatment is the one on power (Fig. 9).

Then as regards heating, a charming little booklet, designed with a cover by Mr. Cecil Aldin, has been got out, the same illustration also being used for a mail-car (Fig. 10). The idea here is to suggests the warm, genial glow of an electric radiator, and the comforting results are depicted by the satisfaction on the dogs' faces, in Mr. Cecil Aldin's unique style.

For an electric power postcard there is a capital design by Mr. L. MacBean, entitled " Two Sides of of the Power Question " showing the old way and the new way; on the one hand the simplicity of the motor, on the other the enormous labour involved in moving a ponderous flywheel.

The same artist has also done a cooking postcard for the committee, showing the advantage of the Electric Oven and its accessories.

Then, upon the question of circulars directly controversial to gas and treating of the points of health and safety, a considerable work has been done by the committee in collating valuable information from medical experts, etc., on this question, and also from various newspaper extracts giving facts.

One of the best productions of the committee is undoubtedly the electric lighting brochure entitled " Electricity in the Home." This has charming illustrations in colour (Figs. 11, 12 and 13).

The productions of the Publicity Committee may fairly be considered in general to be the end of the long evolution of publicity as applied to supply undertakings. The amount produced has been limited, of course, by the time the committee has been in operation (18 months), but they might quite fairly be said to have created a final standard, both in quality, diction and illustrations.

The foregoing touches, of course, only on a few of the publications, but our readers will sufficiently see the type. To realise what a huge advance has been thus made in publicity literature, it is only necessary to compare the committee's publications with what have been issued individually by an average supply company a few years before the formation of the committee. But it is not only in the foregoing comparison that the publicity matter of the committee comes to the fore in such unrivalled fashion. Even in the widest survey it may be said to have reached a standard which has hardly been excelled in any other commercial field.

THE ELECTRIC WEIGHER.

In most industrial establishments where material is handled in bulk, the conveyer is rapidly superseding other methods of transportation. This has created the necessity for a new method of weighing at least as accurate as the scales used with the older methods of handling in barrows, cars, or other receptacles. The design of the electric weigher is the direct outcome of this necessity. While material is in motion on a conveyer, the former method of leisurely direct comparison of its weight with standard weights is impracticable, and interruption of its motion for the purpose of weighing is distinctly disadvantageous. In order to weigh a continuous stream of material in motion, it is necessary to take into account the instantaneous weight of a definite part of the length of the stream and the speed at which that part of the stream is moving. While the problem was being studied with a view to adapting old methods of weighing and old methods of integrating to the new conditions, it was one which presented many serious difficulties. At a certain point, however, the idea of utilizing electricity was hit upon and the difficulties soon vanished.

The electric weigher is described in the current issue of the " Electrical Review and Western Electrician," of Chicago. It consists of three elements, one corresponding to each of the three terms in Ohm's law. The first, to produce the electromotive force, is a dynamo: the second, to vary the conductivity of the circuit, is a rheostat; and the third, to measure the current, is a meter. The dynamo is subject to the rigorous law that the electromotive force produced is proportional to the strength of the field and the number of conductors cutting across it per second. With a constant field and constant number of conductors in the armature, the electromotive force is directly proportional to the speed. The field is made constant by the use of permanent magnets. The demand for accurate electrical-measuring instruments has resulted in the development of special steels for permanent magnets and special methods of " ageing " after magnetization, so that it is now possible to procure magnets which, when properly mounted, show no deterioration whatever over indefinite periods of time. The rest of the dynamo, or magneto, consists of the usual parts, pole pieces, armature, commutator and brushes. The design of the dynamo and the range of current used are such that armature reaction is not allowed to enter as a disturbing factor; and multiple brushes of a highly perfected material developed in Europe maintain indefinitely a perfect condition of the commutator, and bring the brush resistance under absolute control.

The second element, the rheostat, is controlled by scale beams of the usual lever and knife-edge type. Leaving for the moment the important question of the proper suspension of the conveyor, the construction of the rheostat will be described. The counterpoise of the scale is a cylindrical plunger, which is partly floated in mercury. With every change in the weight on the conveyor the plunger instantly adjusts itself to a new position, thereby at the same time changing the level of the mercury.

The rheostat proper consists of a large number of loops of wire placed in narrow vertical spaces at the two sides of the weigher. Each loop is connected to a platinum-tipped contact point on the inside of the mercury vessel. The current from the dynamo is led into the lower part of the mercury and leaves it by way of the highest contact point, which is below the surface of the mercury. In this way different portions of the total resistance are short-circuited in accordance with the weight.

The plunger constitutes a self-adjusting counterpoise, which operates frictionlessly. The mercury vessel is also a dash pot which quells all vibration. The upper part of the vessel is widened out to form a reservoir, which is partly filled with oil. This protects the mercury from the air and forms a trap to catch any fine dust which may get past the other safeguards mentioned below.

The meter is a form of ampere-hour meter, which has been used for years. It has a single rotating member floated in mercury and revolving in proportion to the flow of current. Friction and wear are eliminated, so that no change can be detected in the meter after years of use.

The method of calibrating the weigher is such, that it is only necessary to have a meter which will always go at the same speed when conveying a given current. This meter fulfils this requirement absolutely. The dial of the meter is, of course, graduated to read in units of weight.

The variation in the specific gravity of mercury, due to changes in temperature, is compensated for by making the mercury vessel of an insulating material whose coefficient of expansion just offsets that of the mercury. To illustrate the importance of this it may be noted that the difference between the expansion of iron and of mercury would cause a difference of one per cent. in the recorded weight between winter and summer, if plunger and mercury vessel were made of iron.

The conductivity of most conductors of electricity, of course, varies with temperature, increasing in some materials while decreasing in others. Effective means for balancing these variations have long been in use, and in the electric weigher the materials are so chosen that the meter has the same rate for a given weight and dynamo speed regardless of the temperature.

In connection with the above, the calibration of the weigher will explain its remarkable accuracy. Each resistance loop is provided with an adjusting rider astride of its two wires. The rider short-circuits the part of the loop beyond it. By moving the rider, an extremely fine adjustment of the resistance of the loop is made. Standard weights are suspended from the scale and the dynamo is run at a known speed and each loop is adjusted until the meter is exactly correct for the corresponding weight. The riders are then soldered permanently in position and the weigher is ready for service.

The electrical system lends itself readily to the attachment of distant indicating and recording instruments of the utmost value, without complication. By simply running two small wires from the totalizing instrument, referred to above as the meter, instruments may be placed in the office of the superintendent or elsewhere, which give a complete record of the tonnage carried by the conveyors.

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The Father of Electrical Science.

William Gilbert of Colchester.

Notes, biographical and otherwise, of the early philosophers, writers, and navigators mentioned by him in "De Magnete." Some curious observations and opinions especially concerning the loadstone and several objects magnetical.

(*Continued from page* 9.)

HERMES TRISMEGISTUS—"the great great"—is the supposed author of many Greek works that have reached us and which constitute practically an encyclopædia of Egyptian wisdom, for they treat of astronomy, medicine and other sciences. Gilbert refers to him, along with Zoroaster and Orpheus, in the last chapter of Bk. V, wherein it is shown that they, like Thales, Pythagoras and other ancient philosophers, recognized magnetic force as animate and believed in a universal soul.

HERON—HERO—of Alexandria, was a Greek mathematician, pupil of the celebrated Ctesibus, and flourished about 260 B.C. His most valuable work, *Spiritualia*, is referred to by Gilbert in Bk. II, Ch. 2.

HIPPARCHUS THE RHODIAN, called by Humboldt "the founder of scientific astronomy and the greatest astronomical observer of antiquity," was born at Nicea in Bithynia (160–145 B.C.). He is the inventor of the astrolabe and discoverer of the precession of the equinoxes, and the results of his astronomical observations are pointed out by Gilbert in different chapters of the last book of *De Magnete*. It was Copernicus, however, who first gave the true explanation of the phenomenon known as the precession of the equinoxes, and Newton who discovered its physical course.

HORTO, GARCIAS AH—CARCIA D'ORTA—celebrated Portuguese botanist who flourished in the sixteenth century, is the author of the well-known work *Coloquios dos simples* . . . which was translated into many languages and was united to the books of C. d'Acosta and Nic. Monardus. The passage to which Gilbert alludes (Bk. I, Ch. 14) treats of the different properties of the loadstone and is to be found in the article entitled *De Magnete*, Lib. I, Ch. 56, pages 178–179, of the abridged Latin translation made by Charles de l'Ecluse in 1893.

LACTANTIUS, LUCIUS COELIUS FIRMIANUS, celebrated orator and extensive writer, of Italian descent, called the "Christian Cicero," died about 316 A.D. Dufresnoy enumerates as many as eighty-six editions of his complete works, besides separate publications, appearing between the years 1461 and 1739. His chief work is *Divinarum Institutionum*, the third book of which is referred to by Gilbert when saying that Lactantius, like the most unlearned of the vulgar, treats with ridicule the mention of both antipodes and of a round globe of earth.

LUCRETIUS (T. LUCRETIUS CARUS) is the Epicurean poet (born B.C. 94–95) author of *De Rerum Natura*. Gilbert makes numerous references (Bk. I, Ch. 1,2 : Bk. II, Ch. 3) saying that Lucretius deems the loadstone's attraction due to the fact "that as there is from all things an efflux of minutest bodies so there is from iron efflux of atoms into the space betwixt the iron and the loadstone—a space emptied of air by the loadstone's atoms (seeds); and when these begin to return to the loadstone, the iron follows, the corpuscules being entangled with each other." The translation of a passage on the subject is thus given by C. F. Johnson ("Nature of Things." 1872, page 291):

First from the stone innumerous atoms flow,
In streams that form an atmosphere around,
Displacing air between it and the stone.
Thus rarefied, the space, the particles
Of metal press, vacated place to fill,
And drag with them the mass to which they're joined:
For nothing is than steel more closely knit,
Nor more compacted in its elements,
Hence, little wonder, if, as said before,
The particles thus streaming to the void
Should drag with them along the chain entire!
And this they do: drag it to magnet stone,
Whereto it close adheres by secret bond.

LYNSCHOTEN—LYNSCHETENSIS—JAN HUGO VAN, who, with Richard Hakluyt, we find mentioned by Edward Wright, in his address "to the most learned Mr. William Gilbert," was a celebrated Dutch navigator (1563–1611) who accompanied Vicomte Fonseca Archbishop of Goa upon his eastern trip and first published a relation thereof during the year 1601.

MARBODEUS GALLUS, who is twice mentioned by Gilbert in the first chapter of *De Magnete*, was a French writer who finally became Bishop of Rennes in 1081, and died at Angers between 1123 and 1125. As has already been said, Marbodeus is supposed to have used the manuscript of Evax for his own work which forms the basis of the well known poem on precious stones frequently reprinted since it first appeared, during 1531. In the latter work are described the alleged magical powers of loadstone and amber, and, in the Freburg 1531 edition, will be found the Commentary of Pictorius.

MARCELLUS EMPIRICUS, who was *magister officiorum* in the reign of Theodosius the Great (379 to 395) states at page 89 of his *De Medicamentis Empiricis*, Venetis 1547, that the magnet called *antiphyson* attracts and repulses iron. Becquerel, in his *Résumé*, Chapter III, adds that the aboves proves these properties were known in the fourth century.

MATTHIOLUS, PETRUS (1500–1577), Italian naturalist and physician, best known by his Commentary originally published at Venice under title *Il Dioscoride*, which is said to contain all that was known of medicine and botany up to that time. By Gilbert, we are told "Matthiolus, translator of Dioscorides, furbishes again the garlic and diamond story, in connection with the loadstone, also that he brings in the fable of Mahomet's shrine having an arched roof of magnets . . . and that he compares the attractive virtues of the loadstone, which pass through iron, to the mischief of the torpedo whose poison passes through bodies and spreads in an occult way."

MAUROLYCUS—MARULLE—FRANCISCUS (1494–1575) was Abbot of Messina, a celebrated geometer and very voluminous writer. His well known *Opuscula Mathematica*, Venice 1575, containing treatises on the sphere, on magnetic mountains, etc, was preceded by his great book on cosmography published during 1543 and followed by many others, like the magnetical book *Problemata Mechanica*, which are noted in Abbé Scina's Catologue. Gilbert mentions Maurolycus (Bk. I, Ch. 1, 17 : Bk. IV, Ch. 1, 18) in connection with variation in the Mediteranean Sea, saying that he discusses a few problems regarding the loadstone, adopting the current opinions of others and that he believes the variation is caused by a certain magnetic island named by Olaus Magnus.

MEDINA, PEDRO DE, Spanish historiographer, born in Seville about 1510. He is the author of *Arte de Nauegar*, 1545, 1555, in the sixth book of which he fully discourses of the magnetic needle, its treatment, etc. Gilbert remarks that, like Petrus Nonius, who seeks the meridian with a mariner's compass or versorium (Spaniards call it a needle) taking no account of variation and possessing but small experience or acquaintance of things magnetic, Medina who does not accept variation has with many errors disgraced the art of navigation.

(*To be continued.*)

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Electricity in Gold Mining.

The Winding Plant of the West Rand Consolidated Mines.

Gold mining on the Rand has now passed the stages when mines, or, rather, claims, were exploited under false pretences with no chance of return to the unlucky shareholders. The position and quality of the gold-bearing reef are much better known than formerly, and it has been recognised that in order to make gold mining pay under conditions prevailing on the Rand it is necessary to deal with large quantities of ore.

To this end "consolidations" have been formed so that many claims could be worked as one mine. This naturally reduces capital outlay and working costs and enables the

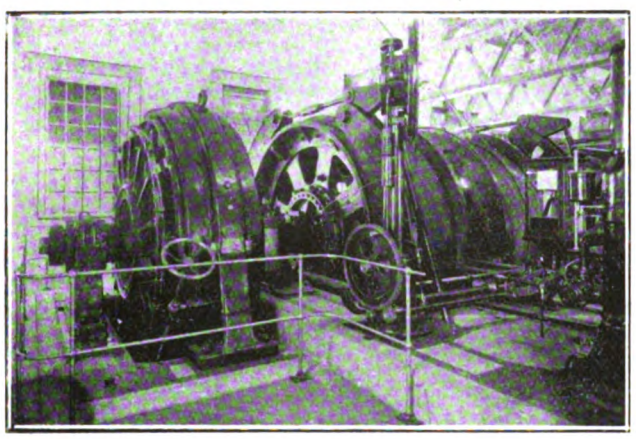

FIG. 1.—650 H.P. HOIST MOTOR.

use of the most modern equipments for winning the ore and recovering the gold.

One such concern is the West Rand Consolidated Gold Mines, Ltd., who are at present working one shaft (the east shaft) and sinking a second on an estate of nearly 2,000 claims situated around Krugersdorp, about twenty miles from Johannesburg. The crushing capacity at the end of 1909 was about 30,000 tons per month, and in 1910 about 70,000 tons per month, and with the completion of the new shaft this figure will be greatly augmented.

The west shaft of this mine, which is at present in course of sinking, is a seven-compartment shaft, and is being

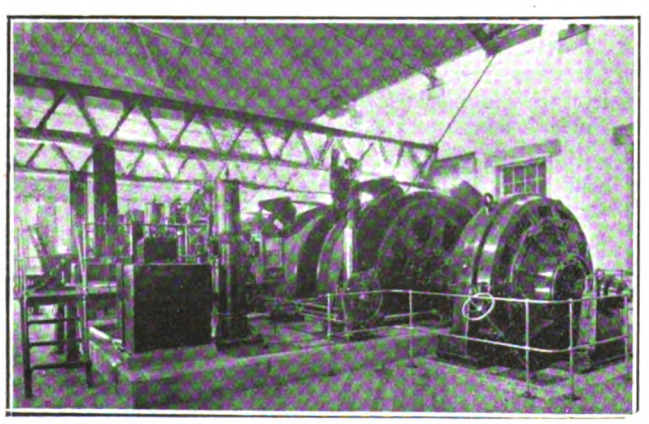

FIG. 2.—480 H.P. WESTINGHOUSE MOTOR DRIVING 3-TON HOIST.

driven downwards at an angle of 50 degrees to the horizontal for an estimated distance of 3,000 feet. Sinking was commenced by means of a temporary headgear, and two small steam sinking engines, and at the same time an order was placed for two double-drum electric winding engines—one suitable for a 6-ton useful load and the other for a 3-ton useful load.

By the time the electric winding engines were installed the permanent headgear was completed, and the shaft had been sunk to a sufficient depth to permit of economical hoisting with the electric hoist. The permanent headgear is built entirely of steel. The engine room is remarkable as it is built of brick, and is very commodious, whereas the usual engine room on the Rand is of corrugated iron construction. Here there are two hoists, and a large space is reserved for a third electric winder to be installed when the shaft is finished and the mine partly developed.

The two hoists were supplied complete, and their erection supervised by the British Westinghouse Electric and Manufacturing Company, Ltd., who purchased such parts as drums, brakes, drum shafts, and bearings from the Dingleische Maschinenfabrik A.G. under the terms of the order. The mechanical equipment of both hoists are almost identical, in spite of the difference in the loads. The motor is shown in Fig. 1.

The services for which these hoists are designed are :—

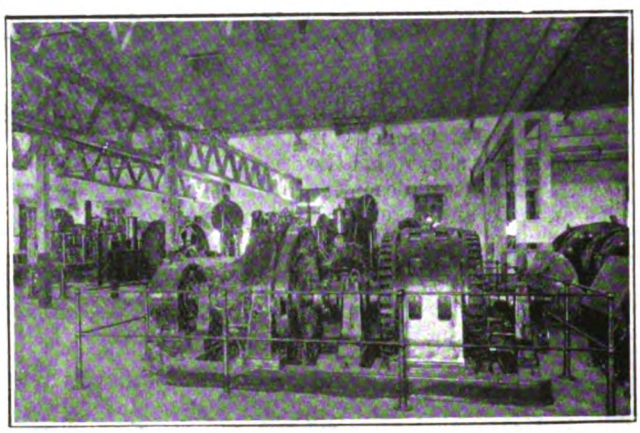

FIG. 3.—650 KW. MOTOR GENERATOR SET.

	Hoist No. 1.	Hoist No. 2.
Inclination of shaft to horizontal	50°	50°
Length of shaft	3000 ft.	3000 ft.
Hoisting speed	2000 ft. per min.	2000 ft. per min.
Weight of rock per wind	1200 lbs.	6000 lbs.
Weight of skip	7500 lbs.	5500 lbs.
Weight of rope	8500 lbs.	6000 lbs.

Each hoist is equipped with two drums, 10 ft. diameter by 3 ft. 9 in. wide between flanges, running loose on the

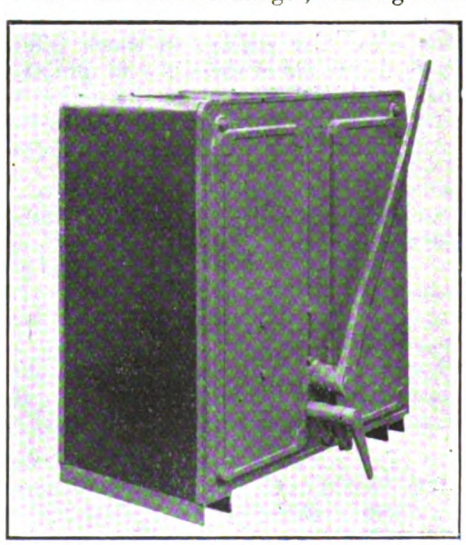

FIG. 4.—EMERGENCY DEVICES.

drum shaft, and driven by multi-tooth clutches sliding and hexagonal sections of the shaft. The clutches are operated by handwheels on the driver's platform.

Post brakes are provided on each drum, of the segmental type supported in the centre, and applied by weights. Compressed air engines with "Iversen" valve gear are used for releasing the brakes. Interlocks are provided so that the brakes cannot be released on a drum that is not clutched to the main shaft. Compressed air for operating the brakes is obtained from a small compressor driven to gearing by a 16 h.p. three-phase, 50 period, 450 volt squirrel-cage induction motor, fitted with automatic starting and stopping gear controlled by the air pressure.

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The position of either cage in the shaft is indicated by two dial depth indicators, driven one from each drum through gearing. Each indicator has two points, one moving slowly during the entire travel of the skip, and the other moving very rapidly during the final part of the wind so as to increase the accuracy of stopping. Automatic devices are provided which bring the skips to a dead slow speed at the tips, and stop the hoist dead should the skips pass that level, irrespective of any action on the part of the driver.

The electrical equipment is designed for operation on the now well-known Ward Leonard system. The winding motors are directly coupled to the drum shaft, and in each case operated at 60 r.p.m. On Hoist No. 1 the motor shown above) is 750 h.p., 600 volt d.c. motor provided with commutating poles. Hoist No. 2 is provided with a 450 h.p. d.c. Westinghouse motor, shown in Fig. 2, together with the drum, driver's platform and other gear. Power for the winding motors is obtained from two motor generator sets arranged so that either hoist may be driven by either motor generator set, provision also being made for the third equipment in contemplation.

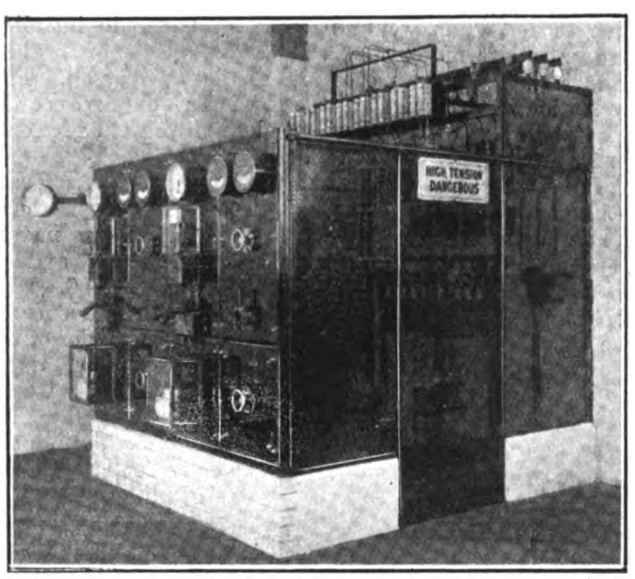

FIG 5.—FOUR-PANEL SWITCHBOARD.

Each motor generator set comprises a 200-volt three-phase 50-period slip-ring induction motor, directly coupled to a d.c. generator and an exciter. The arrangement of the set for No. 1 hoist may be seen in Fig. 3. The a.c. supply for driving the motors of the motor generator sets is purchased from the Victoria Falls and Transvaal Power Company, Ltd.

In the Ward Leonard system the speed and direction of rotation of the winding engines are controlled entirely by altering the strength and direction of the d.c. generator in the motor generator set. This is carried out by means of a special faceplate controller, by means of which any desired speed may be obtained up to the full speed in either direction, the speed corresponding closely to the position of the driver's lever, irrespective of the load. These controllers are fitted with stops controlled electrically from the bank, so that half-speed cannot be exceeded when men are being raised.

An emergency device is provided for each hoist, arranged and connected so that the hoists are quickly stopped in case of:

(1) Overwinding,
(2) Failure of power supply,
(3) Failure of exciting current,
(4) Overloads,
(5) Failure of air supply,
(6) Operation of driver's emergency lever.

There is thus a safeguard against practically any danger that might arise. An illustration of one of these equipment devices is given in Fig. 4.

A four-panel switchboard, illustrated in Fig. 5, is used for controlling the supply of power to the two winding engines, and is arranged to permit the extension when required. The switchboard is equipped with one a.c. and one d.c. panel for each hoist, the former for the motor and the other for the fields of the various d.c. machines.

Although the Ward Leonard system may be readily adapted for use with a flywheel so that no peaks are reflected into the mains, no attempt has been made to equalise the load of the winding engines, since the stations of the Victoria Falls and the Transvaal Power Company, Ltd., are large enough to be untroubled even by the heavy peaks of the large winding engines in use on the Rand.

In conclusion, thanks are due to the engineers of the General Mining and Finance Corporation, who permitted the taking and reproduction of the photographs and figures.

The "Synchron" Apparatus.

The "Synchron" Life-Saving Apparatus for the Promotion of Artificial Respiration in cases of Electric Shock, Drowning, Mine Gas Poisoning, etc., is now being manufactured for us in London and Birmingham under expert personal supervision, and all orders are being filled in rotation as speedily as we can obtain supplies of castings.

Sets of apparatus have already been ordered for the following Power Stations:

LONDON.

City of London Electric Lighting Company, Ltd.
Brompton and Kensington Electric Supply Company, Ltd.
West Ham Borough Council Electricity Dept.
Poplar Borough Council Electricity Dept.
North Metropolitan Electric Power Supply Company, Ltd.
St. Pancras Borough Council Electricity Dept.
The Charing Cross, West End and City Electricity Company, Ltd.
The Metropolitan Electric Supply Company, Ltd.
London Electric Supply Corporation, Ltd.
Stepney Borough Council Electricity Dept.
Islington Borough Council Electricity Dept.
South Metropolitan Electric Tramway and Lighting Company, Ltd.
Croydon County Borough Electricity Works.

COUNTRY.

Glasgow Corporation Electricity Dept.
Clyde Valley Electric Power Company, Ltd.
Manchester Corporation Electricity Dept.
Lancashire Dynamo and Motor Company, Ltd.
The British Thomson-Houston Company, Ltd.
Ayr Corporation Electricity Works.
Messrs. Harland & Wolff, Ltd., Belfast.

ABROAD.

Messrs. Andrew Moir & Company (for South Africa).
Messrs. Strachan Oswell & Company (for South Africa).
The Bakhtiari Oil Company, Ltd.
The Anglo-Persian Oil Company, Ltd.

OTHER ORDERS.

Victoria Falls and Transvaal Power Company, Ltd. (12 machines).
The Mersey Docks and Harbour Board.
The Manchester Ship Canal.
Messrs. H. Simonis & Company, Fire Engineers.
Messrs. Henry Morgan & Company.

TENDERS, ETC.

Buenos Ayres and Pacific Railway Company, Ltd. (12 machines).

Many of the orders referred to are for 6 and 12 machines and upwards.

Inquiries should be addressed to the Manager of the Electrical Engineer, 149, Fleet Street, E.C., by whom illustrated descriptive pamphlets will be sent post free on application.

A highly successful demonstration of the "Synchron" Life Saver was given before the Association of Mining Electrical Engineers (London Branch) on Thursday evening, January 11, at the invitation of Mr. E. Kilburn Scott, M.I.E.E. Mr. R. Hood-Haggie, M.I.E.E., Branch President, was in the chair, and on behalf of the members thanked our representative and expressed his great approval of the apparatus.

The Gesellschaft fur Drahtlose Telegraphie, of Berlin, claims to have supplied the demand for a reliable calling apparatus. Their device includes a sensitive movable coil galvanometer. If the calling station sends for at least 10 seconds the galvanometer needle has time to move and touch a wheel driven by clockwork. The contact closes a circuit, whereby a signal bell is rung.

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The Institution of Electrical Engineers.

SOME GENERAL PRINCIPLES INVOLVED IN THE ELECTRICAL DRIVING OF ROLLING MILLS.

By C. Antony Ablett, B.Sc.*

(*Continued from page* 35.)

In practice the great difficulty with the intermittent-slip regulator is that it is comparatively slow in coming into operation on account of the inertia of the various moving parts. Such slip regulators often take from 1 to 2 seconds to come into operation, and as the power demanded from a rolling mill motor increases practically instantaneously when the rolls bite the bar, the power will rise to its maximum value before the intermittent-slip regulator can come into operation. Thus, instead of reducing the power to the mean value, as would appear to be the action of the automatic-slip regulator from theoretical considerations, it actually is the means of producing very bad peaks indeed.

In many cases, particularly that of the earlier passes of a roughing mill, which is roughing down billets in order to feed an ordinary merchant mill, the intermittent-slip regulator would be absolutely useless, and unless a very large motor were provided the circuit breaker would be continually coming out. The case of a looping mill rolling wire rod would be a good one for the installation of the intermittent-slip regulator, because the power demanded from the motor does not rise suddenly but gradually as the rod is looped into the various pairs of rolls, and the power demanded also increases gradually, so that it gives time for the intermittent-slip regulator to come into operation. The intermittent-slip regulator also finds application for regulating the speed of the flywheel motor-generator set for supplying an electrically driven reversing rolling mill on the Ilgner system.

Where a three-phase rolling mill motor is used, and where the continuous-slip regulator consists of a resistance permanently in the rotor circuit, while the intermittent-slip regulator consists of a resistance which is inserted into the rotor circuit after the power reaches a definite value, the use of these resistances entails a certain waste of power proportional to the amount by which the speed falls, and it would appear at first sight that the waste of power should be less with the intermittent-slip regulator than with the continuous-slip regulator, because with the intermittent-slip regulator the resistance is not always in circuit. Careful tests have shown that this is not the case, and that there is practically no difference between the loss of power taking place in either form of slip regulator.

Arrangement of Motor and Flywheel to suit Power Supply.

The choice of the power of a rolling mill motor and of the weight of the flywheel used in conjunction with it, so as to obtain that relation between motor power and weight of flywheel that will reduce the cost of power to a minimum, depends on whether power is being generated in a power house in the works, or whether power is being purchased from outside; and in the latter case there are various systems of charging for power which materially affect the most favourable proportions between motor and flywheel to be adopted.

Power generated within Works.—In this case the power to be supplied by the power station should be kept as constant as possible. If there are only one or two rolling mill motors and a considerable amount of small machinery of which the power demand will keep fairly constant, the rolling mill motors will tend to cause considerable fluctuations of power, and to ensure that power is being generated cheaply in the power station these fluctuations must be reduced as far as possible by using heavy flywheels with the mill motors, and by arranging the slip regulators so as to allow as much fall in speed as is consistent with obtaining the output from the mills, so that as much of the stored energy of the flywheels as possible may be available for reducing fluctuations in the power.

There is a definite economic limit to the weight which may be adopted for the flywheels because increase in the weight increases both the frictional losses and the capital charges on the plant, and a point will be reached where the increase in running costs due to these frictional losses and increased capital charges will balance the saving effected by running the generating plant at constant load.

If, on the other hand, there are a large number of rolling mills, all of which are likely to be working simultaneously, it would be advantageous under certain conditions to proceed to the other extreme and to reduce the flywheel weight, relying on the natural balancing effect to keep the load constant. Theoretically it would be possible to dispense with flywheels altogether, but this would require that the size of the driving motors should be considerably increased, and it would be found cheaper to install a moderate size motor with a moderate weight of flywheel rather than a large motor and no flywheel at all. This reduction in the weight of the flywheels would reduce the capital charges on the plant, and by reducing the frictional losses would reduce the total power required.

Power purchased on the Maximum Demand System where Instantaneous Peaks are Registered.—At a certain works where a small mill is being driven, the maximum instantaneous demand is about 200 kw., while the average number of units taken per month is about 25,600. Payment is made reckoning the maximum demand over 75 hours per month at 1d. per unit and the remainder of the power at $\frac{1}{10}$ of 1d. per unit. The total cost of power, therefore, works out at £91 3s. 4d. per month. If, however, the power during the working hours was reduced to the average—that is to say, to 53 kw.—payment would be made for 53×75 units at 1d. per unit and for 21,600 units at $\frac{1}{10}$ of 1d. per unit, so that the cost of power per month would be £52 12s. If, therefore, it were possible to keep the power at the average value, a saving of £38 11s. 4d. per month would be made, or £462 16s. per annum. While this case is rather an extreme case, it shows that if a suitably heavy flywheel and a slip regulator were installed to reduce the power to the average, a very large saving would be made after paying the capital charges on this flywheel, etc.

Power purchased at a Flat Rate.—In this case all friction losses should be kept as low as possible in order to reduce the total number of units consumed, while there is no object in attempting to prevent variations in the power. If motors large enough to deal with the largest power required by the rolling mill should be installed without any flywheel at all the friction losses would be reduced to a minimum, giving the cheapest possible power costs, while the maximum possible output could be obtained from the mill on account of the steady speed at which it would run. Such large motors, however, would prove more expensive in capital cost than a more moderate size motor used in conjunction with a flywheel of moderate weight, and it could not be generally stated that the saving in power costs due to the reduction of friction by doing without a flywheel altogether would justify the additional capital outlay, although if a large tonnage from the mill were considered essential the extra capital outlay might then easily be justified. It may be said, however, that in such a case the general tendency would be to reduce the flywheel weight and to increase the motor power.

Power on Maximum Demand System where Peaks of several Minutes duration only are taken account of.—This system of charging is much in favour with the various supply authorities, and the remarks made with regard to case 3 apply to this case also. The variations in power required by most rolling mill motors are very rapid and the peaks last for a matter of a few seconds only, so that they will not be registered by the maximum demand indicator. Care should be taken that the hourly output of the mill is kept as steady as possible, for if the mill were worked rapidly for an hour or two and then there was a long wait for billets to heat in the furnace, or for some other cause,

* Abstract of a paper read before the Yorkshire Local Section, at Sheffield, Wednesday, Jan. 10, and in London on Thursday, January 11, 1912.

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this period of rapid rolling would be found to affect the cost of power very adversely. This, however, is a matter for the mill manager and does not affect the arrangement of the driving plant.

The Ilgner System.

The speed of a rolling mill is settled by the first passes in the roughing rolls, because in these passes the billet is very short, and if it is thrown out at a high speed it becomes very difficult for the men to catch it. During these passes, while the actual power taken may be large, the time of the pass is short, so that the amount of energy consumed is comparatively small and the flywheel does not have to give up much stored energy, and so the speed of the mill is maintained practically at full speed. In the latter passes where the bar has become elongated to a considerable length, the time taken by the pass is considerable—half a minute or so—and while the power may not be very great the amount of energy consumed is considerable and the flywheel will have to vary considerably in speed to give up the necessary amount of stored energy.

In these last passes, where high speed is most desirable to get the bar through the rolls quickly on account of its great length, the speed of the motor has fallen to the lowest limit, and this causes the reduction of the tonnage which it is possible to roll. The reduction of tonnage due to cause is more marked where the mill is engine driven than where it is motor driven. To overcome this difficulty several steel works have adopted the Ilgner system for driving large three-high mills—that is to say, the same type of electrical plant is used which is generally employed for driving reversing rolling mills. In this system the flywheel is not coupled to the mill, but is coupled to a motor-generator set which supplies current to the mill motor. As the mill motor runs at a constant speed whatever power it is required to give, there is no reduction in tonnage owing to reduction in speed in the mill, but the motor-generator set, instead of the rolling mill motor, varies in speed so that the flywheel can give up its stored energy when the power demand is great, and absorb energy when the demand is small, so as to reduce the variation in power taken from the supply system to a reasonable value.

It is obvious that by regulating the field current of the generator of the motor-generator set, the voltage of this machine may be varied, causing the speed of the mill motor to increase or decrease correspondingly, and as there is no flywheel coupled to the mill motor the speed of the mill motor may be increased or decreased very rapidly. In rolling down a billet or bloom, therefore, it is possible to drive the mill at such a speed that while the first passes are being made the billet can easily be caught and then to increase the speed considerably for later passes where the billet has been rolled into a long bar, and where each pass takes a considerable time, so that the times of these long passes can be reduced. In this way the total time for rolling down each billet can be reduced, and the tonnage can be increased. The time taken by these later passes can still further be reduced by increasing the speed after the bar has entered the rolls and then decreasing the speed again before the bar leaves the rolls, so that it is not thrown out at too high a speed. By using the Ilgner system, therefore, the possible output from the mill can be increased beyond that which may be obtained if the mill motor were driven at a constant speed.

The capital cost of the electrical plant for the Ilgner system of driving is considerably more than that of a plain motor and flywheel, but as the cost of the electrical plant is small in comparison with that of the mill and its various accessories, the use of the Ilgner system for driving such a three-high mill may not increase the total capital cost of the plant much. As this increase in capital cost enables a much larger output to be obtained, the use of the Ilgner system in such a case cheapens the cost of production by reducing the capital charges per ton rolled.

Three-phase Current for Merchant Mill Driving.

The roughing rolls of a merchant mill should be run at the highest speed at which it is found practicable for the men to catch the comparatively short billet, and as in most cases about the same size of billet is being rolled the speed should remain constant. The finishing rolls, on the contrary, should be capable of running at a large number of different speeds according to the shape and weight of section being rolled.

Light sections which cool rapidly must be rolled at a high speed so as to finish them while hot, but with heavier sections the rate of cooling is slower, so that there is not the necessity for rolling at a high speed, while there is the advantage that better material is obtained if the speed of rolling is lower. The slowest speed is required for "hand rounds" where the roller has to guide a bar of oval section with his tongs through a round hole, so that the biggest diameter of the oval stands upright, and unless the speed is low the roller cannot follow up the bar.

If the roughing and finishing mills are coupled together and driven by one motor, it will not be possible to run at a sufficiently high speed for the light sections on account of the roughing mill, so that the roughing mill will restrict the output of light sections, while, on the other hand, when rolling "hand rounds" the low speed of the finishing mill will require that the roughing mill also go at a low speed and the output be also restricted. With such a mill the proper outputs can only be obtained at the medium speeds. The ideal drive, therefore, is to provide a constant-speed motor for the roughing mill and a separate variable-speed motor for the finishing mill, and when this is done the roughing mill is usually placed in tandem with the finishing mill.

Where the power available is direct current, this arrangement presents no difficulty, but where three-phase current must be used, the means of providing a variable-speed drive for the finishing mill needs some consideration. The simplest arrangement would be to provide an ordinary three-phase motor, and to reduce its speed when required by inserting resistances in the rotor circuit. This entails such a large waste of power in the resistances when the lower speeds are required that the arrangement is not practicable commercially. In addition, when the power diminishes in the interval between passes or in the interval between the finishing of one billet and entering the next, the speed tends to increase up to the maximum speed, so that when the next billet is entered, it is very difficult to handle the material.

Another arrangement which can only be used where a rope drive can be employed is to provide an ordinary three-phase motor having three rope pulleys of different sizes on its shaft, and to change the ropes from one pulley to another when different speeds are required for the mill. To enable this to be done the motor bedplate has to be made to slide in two directions, so that any one of the three pulleys can be brought opposite the main rope pulley which is coupled to the mill, and so that the motor can be slid away from this pulley in order to tighten the ropes. This arrangement only enables three possible speeds to be obtained which is insufficient to meet most requirements, and it has also proved itself to be very wasteful in power, and on this account it cannot be considered where economy is any object.

Another arrangement which is much more satisfactory is to convert the three-phase current to direct current, and then to provide a direct current rolling mill motor, so that the speed can be varied to any required speed in order to suit all conditions without wasting any power, and with the exception of that variation in speed which is necessary to enable the flywheel to give up and regain part of its stored energy the speed remains constant at the required value.

A still more economical arrangement for obtaining variable speed has been adopted for three merchant mills in this country. This consists of employing a three-phase motor direct coupled to a direct current motor for driving the mill. A rotary converter is connected to the rotor circuit of the three-phase motor, so that when the set is run at reduced speed the power which would otherwise be wasted in resistances in the rotor circuit is converted by the rotary converter from three-phase to direct current, and then used usefully to supply the direct current motor. With this arrangement the direct current motor is provided with a compound winding to act as a continuous-slip regulator, and the combination behaves like an ordinary compound-wound direct current motor, the speed being varied by altering the resistance of the shunt field circuit of the direct current motor, while with the exception of that variation in speed necessary to enable the flywheel to give

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up and regain part of its stored energy, the mill motor set runs at the required speed and does not give trouble by attempting to increase in speed up to the maximum speed between the passes.

Friction Losses.

Particular care should be taken to reduce as much as possible the friction losses, or other such losses which have a constant steady value independent of the power which the rolling mill may be giving, because, generally speaking, the power taken by a motor driving a rolling mill varies between wide limits, so that the average power taken is very much less than the rated output of the motor, and any losses such as those due to friction which go on continuously very considerably increase the number of units of electricity used in a given time. These remarks apply particularly to rope drives when used for rolling mills. To take a practical example, the case of some tin-plate mills may be considered which require a 450 h.p. motor, where the power varies between very considerable limits, and where there is a choice between installing a high-speed motor driving the mills through a rope drive or installing a slow-speed motor direct coupled to the mill.

It may be assumed that the loss in the rope drive is 10% of the full-load power of the motor, that the efficiency of the slow-speed motor is 2% less than that of the high-speed motor, and that the actual power consumption required by the mill apart from the drive is 15,000 units per week. If a slow-speed motor be installed, 2% must be added to the 15,000 units on account of the low efficiency, so that the units consumed in the week will be 15,300.

If the 450 b.h.p. motor ran steadily at its full power, making due allowance for 5% loss in slip resistance, etc., the steady input would be 385 kw.; therefore if the motor ran steadily at its full power for a week of 120 working hours it would consume 45,000 units. Ten per cent. of this, or 4,500 units, are wasted in the rope drive, so that if the high-speed motor with the rope drive be installed, the total units consumed per week will be 19,500, or 4,200 more than if a slow-speed motor be used.

The author holds the opinion that insufficient attention is paid to the question of friction in the pinion housings or on the roll necks, and thinks that improvements might be effected which would reduce this friction, and that any such improvements would materially reduce the cost of rolling.

Various economies can be effected by the electrical driving when properly applied, but one of the principal economies is that of the cost of power. The electrical drive often enables cheap power to be used when it could not be transmitted or applied in any other way, and also in many cases it affords a means of enabling power to be generated cheaply, so that in planning an electrical drive every care should be taken to make use of its natural advantages as far as possible.

COMPARATIVE COST OF LIGHTING WITH CARBON, METAL FILAMENT AND ARC LAMPS.

By "Delta."

It will be generally admitted that considerable progress has been made during the last 10 years in the production and manufacture of incandescent lamps. The carbon filament lamp was first introduced as a commercial article in 1881, and from that time up to 1905 the only great improvements effected chiefly consisted of cheaper methods of production. Before the introduction of metallic filament lamps, several attempts were made to improve the carbon filament by coating it with chromium, tungsten, boron, silicon, and other refractory metals; also with metallic carbides and phosphides, and during the year 1893 an attempt was made to produce a metallic filament consisting of metallic salts incorporated with finely divided platinum or gold.

The present-day types of metallic lamps may be divided into two classes:

(a) Lamps having filaments of tantalum;
(b) ,, ,, tungsten,

or any of the allied metals. There is also a difference in the methods of arranging the filaments, and the power consumption. A consideration of the details of manufacture is too large a subject to be dealt with in these columns, but the following figures, showing the comparative cost of lighting with carbon, metallic filament and arc lamps may prove of interest.

Carbon Filament Lamps.

Using 50–32 c.p. lamps, each taking 3·5 watts per c.p., then total consumption = 50 × 32 × 3·5 = 5,600 watts. If we assume the lamps are burning on an average for 600 hours per annum, then total watt-hours = 5,600 × 600 = 3,360,000, which corresponds to 3,360 units. Assuming a flat rate of 4d. per unit, then cost of lighting on the above basis $= \frac{3360 \times 4}{240}$ = £56 per annum.

Metallic Filament Lamps.

Using 50–32 c.p. lamps of average quality, and having a consumption of 1·2 watts per c.p., then total consumption = 50 × 32 × 1·2 = 1,920 watts. Total watt hours = 1,920 × 600 = 1,152,000, which corresponds to 1,152 units. At 4d. per unit the cost of lighting for 600 hours

$$= \frac{1,152 \times 4}{240} = £194 \text{ per annum.}$$

It will, therefore, be seen that the saving effected by using metallic filament lamps amounts to nearly 66% of the cost with carbon lamps. A comparison of the cost of lighting with metallic filament and arc lamps of the same total candle power may be considered as follows:

Arc Lamps.

Six enclosed-type arcs, each giving about 650 c.p. for a consumption of 550 watts,
∴ 6 arcs consume 3,300 watts.
Assuming the lamps are burning for 600 hours, and the price of current at 4d. per unit, then total cost

$$= \frac{3,300 \times 600 \times 4}{240 \times 1,000} = £33.$$

Substituting metallic filament lamps of equal c.p. for the arc lamps, which give a total of 3,900 c.p., the running cost will be as follows:

Total consumption at 1·2 watts per c.p.
= 3,900 × 1·2 = 4,680.
Cost for 600 hours at 4d. per unit

$$= \frac{4,680 \times 600 \times 4}{240 \times 1,000} = £46\ 16s.$$

In this case, as might be expected, the cost of lighting with metallic filament lamps is higher, and the difference is increased when they are compared with flame arcs, which give a much higher candle-power than the enclosed type of arc. The above example does not take into account the cost of carbons, which should also be considered when comparing the relative cost of each system of lighting.

A comparison of flame and open type arcs is given by the following figures, which represent fairly average results of a series of tests carried out on different lamps of a well known make.

Open Type 12 *ampere Arc.*

Candle-power about 1,000.
Energy consumption = 660 watts.
Cost of carbons about ·135d. per hour.

Flame Arc, taking 12 *amps.*

Candle-power about 3,000.
Energy consumption = 600 watts.
Cost of carbons about ·275d. per hour.

Flame Arc, taking 10 *amps.*

Candle-power about 2,400.
Energy consumption = 550 watts.
Cost of carbons = ·25d. per hour.

Flame Arc, taking 8 *amps.*

Candle-power about 1,850.
Energy consumption = 450 watts.
Cost of carbons = ·225d. per hour.

A syndicate of French financiers has undertaken the task of constructing the electric railway on the north bank of the Lake of Thun for 3,200,000 francs. The work is to be done in two years. The line will pass from Stoffisburg to Thun and Interlaken.

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EXTRA HIGH TENSION WATTMETERS.

The Duddell-Mather Instrument for Measuring Dielectric Losses at 30,000 Volts.

The increasing use of underground cables for long distance extra-high tension transmission brings the question of dielectric losses again into prominence. and makes the measurement of such losses of considerable importance. Makers undertaking the manufacture of extra-high tension cables must be able to determine the losses with fair accuracy in order to give the guarantees required by purchasers.

During the past summer two wattmeters for testing cables at 30,000 volts have been supplied by Mr. R. W. Paul to a well-known Continental firm. and a short description may be of interest. The current capacities of the instruments were 5 amperes and 50 amperes respectively, so that tests on long lengths of cable must have been contemplated, for a current of 50 amperes at 30,000 volts, 50 periods, means a capacity of over 5 microfarads, supposing the wave form sinusoidal.

One of the chief difficulties in measuring dielectric losses in cables arises from the low power factor of good cables, which is of the order 0·02 to 0·03. To measure power by the simple wattmeter method under these conditions instruments having very large overload capacity and high sensibility are necessary. The Duddell-Mather wattmeter possesses these features in a marked degree, and this, we presume, is one of the reasons why the equipment was purchased in this country.

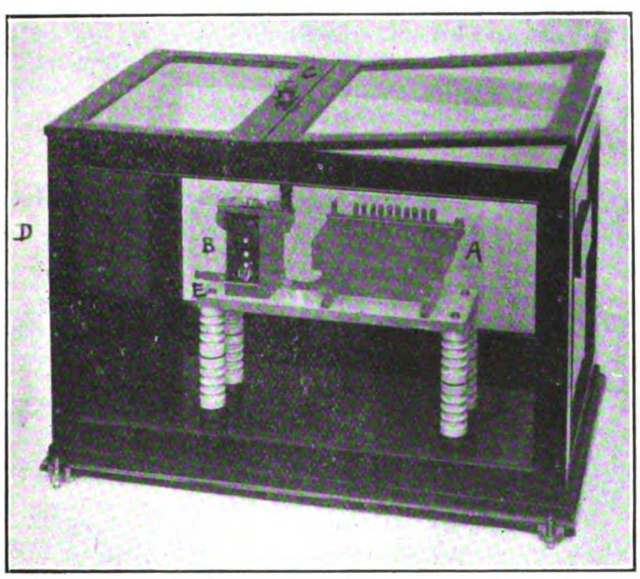

FIG. 1.

The instrument is of the " Zero " dynamometer type, and, as used on ordinary circuits, has been previously described in this journal, so it will suffice now to indicate its main features. These are :—

(1) An entire absence of unlaminated metal in proximity to the moving coils, in which eddy currents might be induced.

(2) Current coils of fine insulated wire stranded together and subdivided into 10 equal sections.

(3) Astatic pressure coils of low inductance capable of carrying continuously 12 times the current necessary to give a full deflexion (360°) with unity power factor.

A plug board is provided on which the sections of the current coils may be connected in series or parallel or series-parallel, thus giving a wide range of current. For example, with a 50 ampere instrument a full deflexion can be obtained by currents from one-third of an ampere to 50 amperes by suitably arranging the sections of the current coils and the resistance of the pressure circuit. The plug board is seen at A in Fig. 1, whilst the wattmeter itself is shown at B. Flexible, well-stranded wires bunched together connect the plug board to the instrument.

The added resistance in the pressure circuit consists of Duddell-Mather anti-capacity non-inductive gauze, by means of which the current in the pressure circuit is kept in phase with the voltage on the circuit, a matter of great importance when dynamometer wattmeters are used in circuit of very low power factor. A set of these resistances renders the instrument suitable for a wide range of pressures.

When a wattmeter is used on very high pressure circuits such as 30,000 volts, electrostatic attractions and repulsions become appreciable, so precautions must be taken to screen the instrument from such disturbing forces and also to ensure safety of the experimenter from shock. These

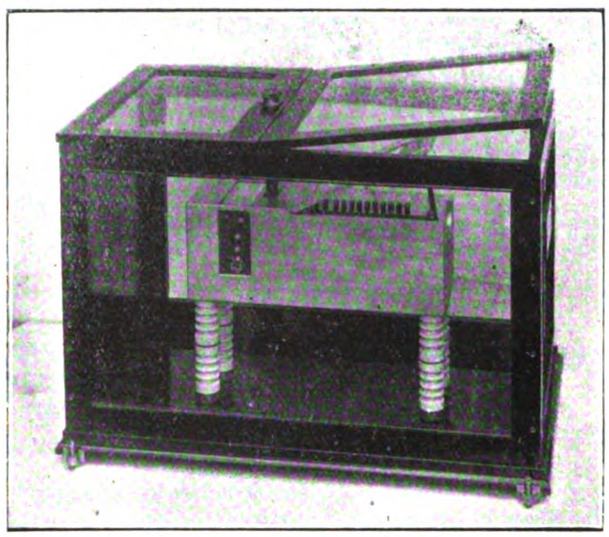

FIG. 2.

desiderata are secured by enclosing the wattmeter and plug board in a wooden box, as shown in Fig. 2, lined with thin foil in electrical connection with the supply side of the instrument, thus forming a Faraday cage, and by supporting this box on long porcelain insulators inside a large case with glass sides and top, as seen in Figs. 1 and 2. There is a clear space of 3 inches between the box and the outer case. Windows in the inner box are provided, through which the pointer and index may be observed.

The torsion head is operated from the outside of the case by a milled head C (Fig. 1) on an ebonite rod some 10 inches long. This rod passes through a brass bush in the top of the case, which is earthed when the instrument is in use. The lower end of the rod turns an ebonite pinion which gears into a wheel cut on the ebonite torsion head. From

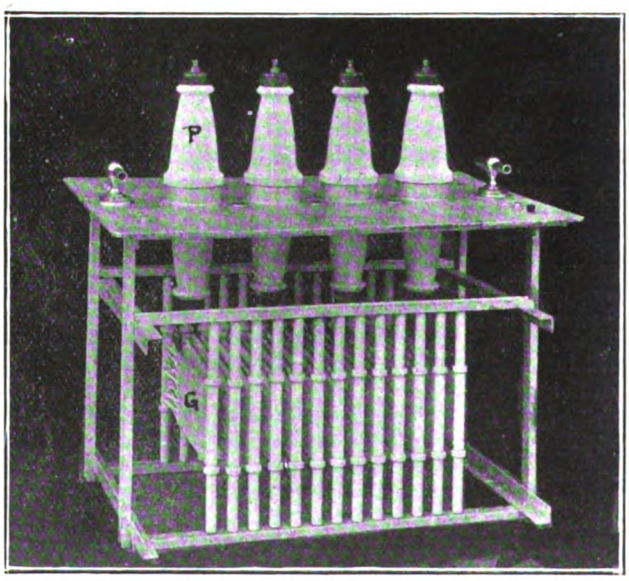

FIG. 3.

these particulars it will be understood that there is little risk of shock in using the instrument and that the moving portions are effectively screened from electrostatic forces.

At the right-hand end of the outer case there are bell-mouthed holes in a wooden block through which heavily insulated cables are led to and from the plug board, whilst at the left-hand end a sliding door D gives access to the clamping head seen at E, Fig. 1.

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The non-inductive resistances used in series with the pressure coils of each wattmeter have a total resistance of 300,000 ohms and will carry one-tenth of an ampere. It is contained in two galvanised iron tanks filled with oil, the interior construction being shown in Fig. 3.

The anti-capacity gauze, G, which is like a ribbon some 7 inches wide, having silk as warp and wire as woof, is carried on porcelain rods, P, supported by a framework from the lid of the tank. Connection with the gauze is made by metal rods passing through long porcelain insulators projecting well above the cover, whilst the lower ends dip into the oil when placed in the tank. There is a minimum distance of about 6 inches between any live metal and the sides of the tank in order that the tank may be earthed whilst the gauze is connected with the 30,000 volt supply.

Before being despatched both the wattmeters and the resistances were tested at the National Physical Laboratory at pressures considerably in excess of the working voltage, with satisfactory results.

"ELECTRICITY IN THE PRINTING OFFICE."

Reply to Problem Propounded in last week's "Electrical Engineer."

At the request of a correspondent the following problem was given in our issue for last week :—

A printing establishment has the following plant driven at present by 14 N.H.P. gas engine placed on ground floor: Ground floor (letterpress)—1 quad crown, 3 double royals, 2 double demys, 2 double crowns, 3 demys, 2 crowns, 5 platens, 1 Harris (single colour); first floor (lithographic)—1 double demy, 1 double crown, 3 demys, 1 offset, 1 crown folio, 2 power transferring presses, 1 bronzer; second floor—3 guillotines, 2 folders, wiring, sewing and stitching machines; lift to take 5 cwt. from basement to top of three storey building, and a small water pump.

It is proposed to convert to electrical drive, local power available, two-phase, 2,200 volt transform to 100 or 200. Compare first cost, economical running, maintenance, special advantages in manipulation (in the two latter methods the best manner of connecting to machine also) of the following methods: Grouping the machines and driving by two-phase motors, individual two-phase drive, and rotary converter with d.c. motor to each machine.

It should be remembered that at times, one or two machines are required to work for a few hours after actual factory times.

A REPLY.

To the Editor of the ELECTRICAL ENGINEER.

Dear Sir,—In reply to the query under the above heading in your current issue it will be obvious that the information given is totally inadequate to enable a full answer to be given to the questions raised.

In the first case the price of gas in the district is not given, nor the price of electricity, which, after all, becomes the main basis upon which the cost of running can be calculated. Further than this, it is almost impossible to advise on the question of individual versus group driving, without first being thoroughly acquainted with the lay-out of the plant.

The third alternative suggestion of driving with a rotary converter with a direct-current motor to each machine may be ruled out of count altogether as being uneconomical in the first instance, and quite unnecessary in an ordinary jobbing office, such as this would appear to be.

Generally speaking, with energy at the rate of between 1d. and 1½d. per unit for power purposes and with gas at 1s. 6d. to 2s. per 1,000 cubic feet, a comparison of the consumption of energy would be in favour of gas, but the cost of upkeep and the convenience in handling is so far superior that electric motors, whether they are put in on the "group" system or the "individual" system, has too far outweighed the slight disadvantage due to a possible 10, 15 or 20 per cent. increase in the actual cost of energy. The proof of this statement lies in the fact that numerous gas engines have been thrown out of printing offices and electric motors substituted.

Generally speaking, one would recommend individual two-phase motors for the larger letterpress machines, and group driving for the smaller machines, including the guillotine, folders, sewing and stitching machines. Those machines which are occasionally required to work overtime should undoubtedly be provided with individual motors, and it is an ordinary testimony to the convenience of this arrangement that one finds in printing offices where both group driven and individually driven presses are installed, with the result that the latter are almost always full of work, while the former are oftentimes seen standing.

The electric lift should be equipped for electric driving, and although this may involve some considerable expense owing to the difficulty of applying a motor to an existing and often inefficient mechanical winding gear, the saving in consumption of energy would justify this expense.

Very efficient rope controllers are now manufactured for operating these warehouse lifts, which require very little attention and are perfectly safe to use.

The writer was responsible for the equipment of an office in Sheffield, where about 16 two-phase motors were installed in place of an old steam engine drive, and the results have in every way proved most satisfactory.

The following machines were individually driven :—

Victory cutting machine.
Moffatt cutter.
Trimmer.
Quad crown Dawson letterpress machine,
Litho stone polisher,
Double crown litho,
Double royal Summit,
Single royal Reliance wharfedale,
Double royal Bill machine,
Double royal Dawson,
Double royal two-colour,
Quad crown Dawson,
Marinoni quad crown perfecter.

In addition to the above there was a short shaft provided with one motor for driving two folders and two wire stitchers.

In the case of some of the machines speed regulation was provided to meet the conditions of the work which these machines were called upon to produce, the speed variation obtainable varied from the maximum down to about 50% of the maximum speed.

Most of the motors were connected to the driving shaft of the press by spur gearing, but in some cases, owing to difficulties in the weight, the existing belt pulleys were used.

The installation referred to was carried out in March, 1908, and in no single instance has a motor been replaced nor have any spare parts been supplied.

R. A. MARPLES

(Adnil Electric Company, Ltd., London).

DINNER TO PROFESSOR UNWIN.

Professor Unwin, being one of the very few teachers who have been honoured by being made President of the Institution of Civil Engineers, the Old Students' Association of the Central Technical College is organising a dinner to celebrate the occasion. The dinner is intended to be a gathering of all the old students of the Central Technical College and all Professor Unwin's students at Cooper's-hill. It bids fair to be a very representative gathering of those who have had the advantage of Professor Unwin's kindly teaching and advice. The Old Students' Association has asked us to draw attention to the dinner as many of our readers have probably been students under Professor Unwin, and will wish to be present on the occasion. The dinner will be held at the Criterion Restaurant, Piccadilly, on Saturday, February 10, at 7 for 7.30 p.m. The chair will be taken by the President of the Central Old Students' Association, Mr. W. Duddell. Those who wish to take part in the dinner should communicate with the Dinner Secretary, Mr. G. W. Tripp, 4, Fairfield-road, Charlton, Kent. The price of the tickets is 7s. 6d.

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Technical Problems and their Solution.

QUESTIONS AND ANSWERS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways, and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for the next best, but in the case of two replies adjudged to be of equal merit, these two sums may be added together and divided. Replies should reach the office within seven days of the appearance of the questions.

QUESTIONS.

Problem No. 1270.—When using a universal shunt in conjunction with a galvanometer it is best to have the total resistance of the universal shunt not greatly differing from that of the galvanometer, for if the resistances of galvanometer and shunt are disproportionate a loss of sensitiveness occurs. Explain the reason for this.—" BICKNOLLER."

Problem No. 1271.—Explain—with theoretical justification—a method of measuring fault resistances, applicable to 3-phase or 2-phase 3-wire networks. Simplicity is important.—" QUERIST."

Problem No. 1272.—On a three-phase circuit of shaft cables there are two pumps; one a turbine the other a three-throw. Starting up the three-throw causes a wattmeter coupled to one phase (balanced load) to revolve in its correct direction. Starting the turbine one now causes the disc to slow down, stop, and revolve in the opposite direction. Turbine works at half normal head. Pressure coil of wattmeter is connected to a potential transformer phase to neutral.—" P. F."

Problem No. 1273.—A revolving-field alternator with direct-coupled exciter, driven by a direct-coupled steam engine is to supply a 90 b.h.p. 6-pole constant speed induction motor; the system being three-phase, 750 volts, 40 cycles. As the motor would start only twice a day, it is proposed to use a squirrel-cage motor connecting it to the alternator through a protective device, without any special starting apparatus; the motor to be started by running up the generating set. The alternator has average characteristics and the motor would have:—Speed 783 r.p.m., efficiency 92% and power factor 93% at full load. No-load current 12 amps. and stand-still current 302 amps. (at a power factor of 23·4%) per phase. Ratio of transformation 8·6. Stator star connected; resistance hot ·182 ohms per phase. Show the relation between torque of the motor and voltage, current, frequency, and power factor at starting; also state any objections to the scheme.—" SQUIRREL-CAGE."

ANSWERS.

Problem No. 1269.—It is required to measure insulation resistances varying from one megohm to 50,000 megohms, using a galvanometer of 150 ~ sensitivity and 800 ohms resistance. State, with reasons for preference, which of three universal shunts having a total resistance of 100,000, 10,000, and 1,000 ohms respectively, would be most suitable for use with this galvanometer for obtaining the required measurements. " BICKNOLLER."

Answer to No. 1269 (*awarded* 5*s.*).—The accompanying figure shows the arrangement of the apparatus for determining the insulation resistance of a cable. From this it is evident that we want the galvanometer to give the maximum deflection for a given current in the main circuit when we are testing the cable possessing the highest insulation resistance. Now in considering the effect of varying the ratio of the resistance of the shunt and the galvanometer upon the sensitiveness of that instrument, it can be shown mathematically that there are two separate cases (a) when the resistance of the shunt is constant, and that of the galvanometer variable, and (b) when the resistance of the galvanometer is constant, and that of the shunt variable, and that the conditions for maximum sensitiveness in these cases are that in (a) the two resistances should be equal, whereas in (b) the shunt resistance should be infinite.

In the question under consideration, the galvanometer is given as 800 ohms, and therefore for the greatest sensitiveness the total shunt should be made as big as possible, that is, the universal shunt having 100,000 ohms as its total resistance should be used.

That this is so is quite obvious if we examine the following two examples, in one of which the total resistance is 1,000

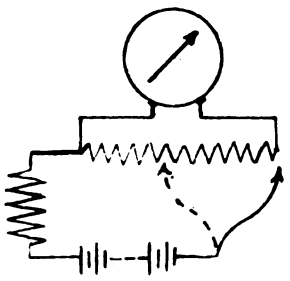

FIG. 1.

ohms, and in the other is 100,000 ohms. Now, assuming the main current to be constant (and this is practically true since the combined resistance of the shunt and galvanometer is negligible compared with the insulation resistances of the cable), then in the first case the galvanometer current $= Cm \times \frac{1,000}{1,800} = \cdot 55$ Cm, and in the second case, the current $= Cm \times \frac{100,000}{100,800} = \cdot 995$ Cm, and since the tangent of the angle of deflection is proportional to the current through the galvanometer, it is evident that the deflection in the second case is much larger than that in the first case.

Of course, it so happens that " Bicknoller " possesses a galvanometer having a very high degree of sensitiveness, then it may be that he will obtain an inconveniently large deflection when using the whole of the 100,000 ohms even with the cable of highest insulation resistance. If that is so, then he ought to use the 10,000 ohm shunt or perhaps even the one with 1,000 ohms, that is, he should use the shunt having a total resistance such that he obtains with the cable of highest insulation resistance that he is likely to meet, the maximum convenient deflection.

As to the statement that the galvanometer possesses " 150 ~ sensitivity," we do not follow what this is supposed to imply. If it refers to the frequency of the moving system in the galvanometer, then it is quite irrelevant to the question, since the instrument is not used as a ballistic galvanometer, but is to give a steady deflection.—" E. H."

Second answer to No. 1269 (*awarded* 5*s.*).—Although the " universal shunt box " has an advantage in that it may be employed with any galvanometer, many electricians prefer the ordinary method of shunting galvanometers. A galvanometer intended for the measurement of insulation resistances should by preference be one that will respond to a very small current; on the other hand, galvanometers most useful to the electrical engineer for the purpose of fault finding and locating, are those that are sensible to small changes in voltage. Galvanometers are usually classed with regard to their " figure of merit." That is, the current that will give a deflection of one division; what is meant by a sensibility of 150 periods is not quite apparent.

The universal shunt having a total resistance of 100,000 ohms would be the best, for the reason that accuracy is more nearly attained as the resistance of the shunt

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approaches infinity when compared with the resistance of the galvanometer.

For the purpose required an ordinary shunt box, suitable for the galvanometer, with shunts of $\frac{1}{10}$, $\frac{1}{100}$, and $\frac{1}{1,000}$ should meet the case. With a testing voltage of 500 the current through 50,000 megohms would only be

$$\frac{500}{50,000 \times 10^6} = \frac{1}{10^8} = 10^8 \text{ ampere.}$$

Suppose that with this current one division is obtained. Then 25 divisions would be given by $\frac{50,000}{25} = 2,000$ megohms. With a $\frac{1}{10}$ shunt 200 megohms would give 25 divisions and a $\frac{1}{100}$ shunt 25 divisions by 20 megohms. The $\frac{1}{1,000}$ shunt would give the 25 by 2 megohms, and as the scale could be arranged to reach to 50 divisions, with this combination measurements could be made between 1 and 50,000 megohms. Measurements of this kind are often taken by means of a ballistic galvanometer, and a condenser by the "loss of charge" method.—"M. M."

Third answer to No. 1269 (*awarded* 5*s*.).—The most suitable universal shunt, of the three mentioned, for use with an 800 ohm galvanometer, is that having a total resistance of 100,000 ohms, as this gives the most sensitive combination.

When the universal shunt is set to give a multiplying power of "1" (the most sensitive condition), the galvanometer is shunted with the total resistance of the shunt, and, unless that is high compared with the galvanometer resistances a loss of sensitiveness occurs. The most sensitive arrangement is obviously obtained when the ratio of the line current to the galvanometer current is unity.

Let C = line current.
C_1 = galvanometer current.
R = shunt resistance.
R_1 = galvanometer resistance.

Then the ratio

$$\frac{C_1}{C} = \frac{\frac{E}{R_1}}{\frac{E}{R} + \frac{E}{R_1}} = \frac{R}{R + R}$$

(where E = E.M.F. across the galvanometer and shunt terminals).

Supposing the 1,000 ohm shunt is used,

$$\text{then } \frac{C_1}{C} = \frac{1,000}{1,000+800} = \frac{10}{18}$$

If, on the other hand, the 100,000 ohm shunt is used,

$$\text{then } \frac{C_1^1}{C} = \frac{100,000}{100,000+800} = \frac{1,000}{1,008}$$

and the increase in the galvanometer current, assuming the same line current to remain constant, will be :—

$$\frac{\frac{C_1}{C}}{\frac{C_1^1}{C}} = \frac{\frac{10}{18}}{\frac{1,000}{1,008}} = \frac{C_1^1}{C_1} = \frac{1,800}{1,008}$$

The sensitiveness of the combination is therefore very nearly doubled in the second case.

In order that the required range of from 1 megohm to 50,000 megohms may be conveniently covered, the shunt should be sub-divided to give multiplying powers of 1, 10, 100, 1,000. 10,000, that is the resistance between the various steps should have values of 100,000, 10,000, 1,000, 100 and 10 ohms respectively.—"M. J."

Wireless Telegraphy.

Some few weeks ago the New York Correspondent of the ELECTRICAL ENGINEER transmitted a brief account of the wireless experiments of Major George Owen Squier, of the United States Signal Corps, with a special type of dynamo, capable of producing 100,000 cycles per second and of operating regularly at 20,000 cycles. In response to many requests on the part of our readers, we now give the text of Major Squier's paper, which was read at a meeting of the New York Electrical Society. Major Squier said :

During the past twelve years the achievements of wireless telegraphy have been truly marvellous. From an engineering viewpoint, the wonder of it all is that, with the transmitted energy radiated out over the surface of the earth in all directions, enough of this energy is delivered at a single point on the circumference of a circle, of which the transmitting antenna is approximately the centre, to operate successfully suitable receiving devices by which the electromagnetic waves are translated into intelligence.

The "plant efficiency" for electrical energy in the best type of wireless stations yet produced is so low that there can be no comparison between it and the least efficient transmission of energy by conducting wires. The limits of audibility, being physiological functions, are known to vary considerably, but they may be taken to be in the neighbourhood of 16 complete cycles per second as the lower limit and 15,000 to 20,000 cycles per second as the upper limit. If, therefore, there are impressed upon a wire circuit for transmitting intelligence harmonic electromotive forces of frequencies between 0 ans 16 cycles per second, or, again, above 15,000 to 20,000 cycles per second it would seem certain that whatever effects such electric wave frequencies produced upon metallic lines, the present apparatus employed in operating them could not translate these effects into audible signals.

The electromagnetic spectrum at present extends from about four to eight periods per second, such as are employed upon ocean cables, to the shortest waves of ultra-violet light. In this whole range of frequencies there are two distinct intervals which have not as yet been used, viz., frequencies from about 3×10^{12} of the extreme infra-red to 5×10^{10}, which is the frequency of the shortest electric waves yet produced by electrical apparatus, and from about 80,000 to 100,000 cycles per second to about 15,000 to 20,000 cycles per second. The upper limit of this latter interval represents about the lowest frequencies yet employed for long-distance wireless telegraphy. Within the past few years generators have been developed in the United States giving an output of 2 kw. and above at a frequency of 100,000 cycles per second, and also capable of being operated satisfactorily at as low a frequency as 20,000 cycles pre second. Furthermore, these machines give a practically pure sine wave.

The necessary conditions for telephony by electric waves guided by wires are an uninterrupted source of sustained oscillations, and some form of receiving device which is quantitative in its action. In the experiments described in multiplex telephony and telegraphy it has been necessary and sufficient to combine the present engineering practice of wire telephony and telegraphy with the engineering practice of wireless telephony and telegraphy. The frequencies involved in telephony over wires do not exceed 1,800 to 2,000, and for such frequencies the telephonic currents are fairly well distributed throughout the cross-section of the conductor. As the frequency is increased the "skin effect" becomes noticeable.

At frequencies of 100,000 cycles on wire circuits the phenomena may be considered as a "super-skin effect" or "film effect," where the actual mass of the metal conductor involved is but a small fraction of the total. At such frequencies the flow of energy is controlled by reactance, rather than by the resistance of the wire as in battery telephony and telegraphy, and when these reactances are balanced at the receiving end of the circuit by the process of electrical "tuning" the one hundred thousand small packages of energy in the form of electromagnetic waves, which are delivered in each second of time at the receiving end of the circuit, are thus added together to produce a cumulative effect many times greater than without such electrical tuning process. These waves are guided by wires with the velocity of light in free space, and are made the carrier of telephonic or telegraphic messages, or both, according to the principles used in the wireless arts. Furthermore, it has been found possible to superimpose, upon the ordinary telephonic wire circuits now commercially used, electric waves of ultra-sound frequencies, without producing any harmful effects upon the operation of the existing telephonic service. Fortunately, therefore,

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the experiments described are constructive and additive, rather than destructive and supplantive.

Electric waves of ultra-sound frequencies are guided by means of wires of an existing commercial installation and are made the vehicle for the transmission of additional telephonic and telegraphic messages. The source of electric waves used in the experiments described was a special type of dynamo, capable of producing 100,000 cycles per second and also capable of operating regularly at 20,000 cycles. This gave a wide range of frequencies for tests over an actual commercial telephone line of about 776 ohms resistance and capacity of 0.7 microfarad. The cable, being lead-covered throughout, practically corresponded to a submarine cable about seven miles in length. The generator was of the inductor type and the rotor operated at a speed of 20,000 revolutions per minute or would roll as a wheel from the United States to Europe in four hours. The friction, or adhesion, of the air against the rotor was so great at this speed as to require five kilowatts to overcome this alone, although the total output of the machine is but two kilowatts. Severe tests were described to determine the efficiency of a single wire with earth connection as a circuit for commercial telephony by high-frequency methods, and these tests showed that such circuits are entirely practicable for this work, thus doing away with the necessity of constructing two wires for a telephone toll circuit, as is now required. Since the inductances and capacities required for this range of frequencies are a thousand times smaller than those employed in battery signalling, the complete and absolute separation of two independent telephonic conversations on the same pair of wires was readily obtained.

The engineering data obtained from a study of this particular cable line was presented in the form of typical resonance and selectivity curves at frequencies ranging from 20,000 to 100,000 cycles per second. The transmission of energy at these ultra-audible frequencies was so radically different from the phenomena at low frequencies by metallic conduction, that the results very closely resembled pure radio-telegraphy. The energy waves were broken away from the source as from a transmitting antenna, and thereafter had no perceptible reactive effect upon the source at the transmitting station. It was, therefore, not possible to tell from the transmitting station whether or not the distant end of the line was open or short-circuited.

Since the loss of energy on the metallic "film" of the line in transmission is proportional to the square of the line current, it is permissible to put the energy in any form desirable for transmission and this is controlled by the ratio of transformation of the oscillation transformer at the transmitting station. With a ratio of but one to five, excellent speech was obtained with a transmitting line current almost too small to be read on any commercial ammeter.

In battery telephony this ratio is below one to twenty, so that the line currents may be small, and therefore, line losses decreased inversely as the square. The ringing circuit was operative both ways with no apparent effect on the high-frequency telephone transmission. This ringing circuit develops a comparatively large alternating current flowing in the wire at about thirty cycles per second and at a voltage of many times that of either the high-frequency or the battery side of the circuit.

Articulation tests, including music, numerals and other difficult combinations, gave satisfactory results, with no interference whatever between the two sides of the circuit. By holding one telephone receiver to one ear and the other receiver to the other ear the receiving operator could hear two entirely different conversations simultaneously over the same pair of wires. The distortion of speech, which is an inherent feature of telephony over wires, should be much less, if not practically absent, when we more and more withdraw the phenomena from the metal of the wire and confine them to a longitudinal strip of the ether which forms the region between the two wires of a metallic circuit. The tuned electrical circuit at the receiving end readily admits electromagnetic waves of a certain definite frequency, and bars from entrance electromagnetic waves of other frequencies. This permits the possibility of utilizing a single circuit for multiplex telephony and telegraphy.

"THIS ELECTRIC AGE."

The address on the Engineer and Citizenship (already summarised in the ELECTRICAL ENGINEER) which was delivered at Los Angeles recently by Mr. James B. Scherer, president of the Throop Polytechnic Institute, was prefaced by a little story which may be worth transcribing.. It purported to be a statement made by a Member of Congress. "Thirty years ago," said this personage, or at any rate President Scherer said, he said, "I walked six miles over a hot and dusty road from my country home to the county-seat to see a circus that advertised to have on exhibition a light made of electricity. There were scores of others in our neighbourhood who went, not to see the circus, but to get a sight of this new marvel, the electric light. That was thirty years ago. Last month, on the advice of my physician, I went out to a suburban sanatorium for treatment for a rheumatic trouble. At the corner I took an electric car that carried me to the suburbs. There I entered an electric automobile that whisked me a mile further, to the sanatorium. Having arrived there, I was taken by an electric elevator to my room, where the attendant turned on the electric light and switched on the electric fan. A moment later the house physician came in. On leaving me, he said that I would be notified when to come down to the treatment room. Soon after his call an electric sign on the walls flashed the words 'Treatment Room.' On going down to that apartment, I had an electric-light bath, after which the physician applied electric sponges to my aching joints. When I returned to my room the electric telephone at the head of my bed rang, and lying there, I talked to my secretary in the House office building in Washington. He had called me up to ask after my health. Just before day the next morning I awakened, and desiring some hot milk, summoned the night attendant by pressing an electric button. When I made known my wants the attendant retired, returning in a few moments with a small electric stove, on which he soon heated a palatable drink. Before rising that morning I had an electric massage. The nurse told me that he had just been attending a patient with a chill, and had materially relieved him by packing electric bed-warmers about him. During the forenoon I had a slight attack of nervousness. I was placed in an electric chair—not *the* electric chair—and its gentle vibrations soon sent me off into a soothing sleep. During the afternoon I had occasion to communicate with a colleague on a matter that I did not care to trust to the telephone. Accordingly, I telephoned to my secretary to have the member in question call me on the telautograph punctually at a certain minute. This he did, within a quarter of a minute of the time I had set, for the clock at the sanatorium and the clocks in the House building are both connected by electric wire with the government official clock at the national observatory, and regulated to the second each day. Then I sat down and carried on a secret correspondence on an electric telautograph, by means of which the words were written by electricity at a distance of eight miles. When I recovered sufficiently to walk I strolled one day up the valley to the source of all this power. It was a humble little stream that tumbled down through an iron pipe to a turbine wheel."

BRITISH ELECTRICAL & ALLIED MANUFACTURERS' ASSOCIATION.

The annual general meeting of this association will be held on Thursday, February 1, at 2.30 p.m., at the offices, 36, Kingsway, London, W.C. The business to be transacted will include the presentation of the annual report and balance sheet and the election of a new council. The following firms have recently been elected members of the Association, and any member who desires to nominate them for the new council will be economising time at the annual meeting by advising the secretary in advance of his intention: Messrs. Allen, W. H., Son, & Company, Ltd., Belliss & Morcom, Ltd., Electric Construction Company, Ltd., The Morgan Crucible Company, Ltd., Siemens Brothers Dynamo Works, Ltd., Switchgear and Cowans (1911) Ltd., Willans & Robinson, Ltd.

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Electrical Progress at Home and Abroad.

UNITED KINGDOM.

Lighting, Power, Telegraph, Telephone, and General Business Notes.

ACCRINGTON.—The Corporation is seeking sanction to a loan of £33,750 for extensions to the electricity undertaking. The proposal is to instal gas generating plant in place of steam, by which is is expected to effect a saving of £1,100 per annum. The proposed loan will also cover an extension of supply to Altham and Clayton-le-Moors.

BEDFORD.—Mr. T. C. Ekin, in the course of a Local Government Board inquiry into the application of the Town Council for sanction to a loan of £22,887 for extensions to the electricity undertaking, to be carried out during the next five years, intimated that the Board would not grant the application in its present form as there was nothing definite in the particulars as to the machinery or the buildings. For the mains, meters and services he thought the Board would grant them sufficient for their requirements for three years. Mr. Phillips, the Borough Electrical Engineer, said he had hoped to be able to manage without new machinery for three years, but now he was sure he could not because of the new business coming in. As to the buildings, Mr. Stimson, the Town Clerk, agreed that it would be more business-like for the Council to apply for a loan when they had made up their minds as to exactly what they proposed to do, and after that conversation he would formally reduce the loan and confine it to the mains, services, and transformers for three years, namely, mains, £3,500; services, £700; meters, £1,300; transformers, £600; public lighting, £2,200; legal, £100; total £8,400. As to the meters, the Inspector observed that the concern had not had many profits, or he would suggest that the meters be paid for out of revenue. The Board would not grant more than five years for the repayment of that sum. Mr. Phillips replied that he thought the concern had come to the end of its deficits. It picked up £800 last year. In all, £2,957 profits had been made by the concern, and £8,461 6s 11d. had been paid to it out of the rates. The inquiry was closed.

BIRMINGHAM.—At a meeting of the City Council it was resolved, on a recommendation of the Electric Supply Committee that in lieu of the extensions at Dale End sub-station, sanctioned by the Council in March, 1909, the Committee be authorised to provide a storage battery at a cost of £13,110, and necessary buildings at a cost of £12,130, and that application be made to the Local Government Board for sanction to borrow £19,200. It was also recommended that, in lieu of the sub-station at Harborne, a sub-station be erected on land in War-lane, at a cost of £9,515, and that application be made for sanction to borrow that sum. It was also resolved that a plot of land be acquired in Percy-road, Greet, at a cost of £275, as a site for an electric sub-station; that high-tension trunk mains be laid connecting the Summer-lane and Aston Manor generating station, at an estimated cost of £5,500, and to provide two rotary converters and transformers at the Aston Manor station, at a cost of £7,531; that induction motors and converters be supplied at the Handsworth station, at a cost of £4,428, and high tension trunk mains be laid from the Summer-lane generating station to the Handsworth station, at a cost of £6,000.

BROMLEY.—At a meeting of the Rural District Council it was reported that a letter had been received from the Bexley Urban District Council upon the question of electric energy at North Cray, and the Council passed resolutions consenting to the application about to be made to the Board of Trade by the Bexley Urban District Council for permission to give a supply of electricity to premises at North Cray, and that for purpose with the supply, the Council consented to the laying by the Bexley Council of a cable from the boundary of the parish of Bexley along the highway known as North Cray, at the foot of the bank on the south-east side of the road, subject to the payment to the Council of £6 in respect of the reinstatement of the highway.

CHELTENHAM.—At a meeting of the Chamber of Commerce attention was called to the fact that the Corporation was asking for powers to supply electricity to Leckhampton, Prestbury, Swindon, Badgeworth, Shurdington, Up-Hatherley, Bishop's Cleeve, Woodmancote, Southam, and Brockhampton—an area twice the size of that over which they at present exercised powers. Mr. Marshall, who brought the matter forward, said no estimate had apparently been made of the cost, and he objected also to the clause which authorised the Corporation to hire, sell, fix, maintain and repair lamps, motors, engines, and to do various other things. The matter was referred to the Council of the Chamber with a view to opposing the Corporation's Bill in Parliament.

DUNDEE.—It is proposed to erect a new sub-station in Dock-street at a cost of £7,200. Mr. H. Richardson, the Electrical Engineer, has pointed out that the load at present is so heavy that they have both turbines working, while the machinery in the old station is almost continuously running. A committee was appointed to look into the whole question.

EALING.—At a meeting of the Council the district auditor reported that the net profit on the undertaking for the past year amounted to £1,665 as against £2,005 for the preceding year. This showed a decrease of £340. Owing to the large number of new consumers the sales of current continue to increase in the aggregate. The total of loan raised during the above period amounted to £140,494.

EPSOM.—The work of installing the Strowger automatic telephone is now in active progress, and it is anticipated that by the middle of March 500 subscribers will be enabled to use the system.

HAMPSTEAD.—At a meeting of the Borough Council it was agreed that the resignation of Mr. G. H. Cottam, the Chief Electrical Engineer, be accepted and that his duties in the capacity shall cease on July 12. On the motion of the Lighting Committee that the question of granting Mr. Cottam a superannuation allowance be referred to the Finance Committee, it was moved as an amendment by Mr. Ashenden, that the recommendation be deferred until after a Local Government inquiry had been held, and this was seconded by Mr. Symmons and carried. Mr. O'Bryen, chairman of the Public Lighting Committee, said the excess expenditure of £10,398 on the estimate of £15,000 would be paid off out of the electrical undertaking's reserve fund, and then repaid the fund in eight annual instalments out of the profits of the undertaking, so that for a few years those profits would not go as heretofore, to the relief of the rates. The cheaper light provided would, however, soon right this. The committee had contracted to light the streets at the rate of £2 5s. a lamp, as compared with £3 4s. 9d. a lamp previously paid to the gas company, and this would result in a saving equalling a penny rate. A letter was read from the Assistant Electrical Engineer, Mr. E. Sayer, expressing surprise at being summarily dismissed from his position without having any opportunity of defending himself before the Council, and demanding three months' salary (£97 10s.) in lieu of notice. The committee's recommendation that the Council should repudiate liability for the payment was agreed to.

HEREFORD.—Mr. E. R. Dymond, A.M.I.C.E., chairman of the Electric Light Committee, delivered an able lecture on "Electricity in Domestic Use" at a gathering at the Town Hall in aid of the All Saints' Tower fund, and expounded the advantages of electricity in respect of heating and cooking as well as lighting. The Mayor, Alderman Wallis, who presided, mentioned that the Corporation's electricity works cost £51,000, to which the ratepayers had contributed about £1,400.

LIVERPOOL.—A report of the resident electrical engineer to the Tramways and Electric Power and Lighting Committee upon the supply for eleven months of last year shows

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a considerable increase in the use of electricity for power in the city. The units supplied from January 1 to November 30 for lighting were 8,279,473, an increase of 1·389% on the corresponding eleven months in 1910; for traction 20,575,097, an increase of 1·442%; and for power 4,821,019, against 3,701,821, an increase of 30·234%. The total number of units supplied during the period was 33,675,589, against 32,150,416, an increase of 4·744%.

LOWESTOFT.—The net surplus of the Corporation Electricity undertaking for the year ended September 30 was £99 11s. 4d., after providing for the sinking fund charges, interest on capital, and after deducting the deficiency on the cottages of £241 10s. 10d. The revenue account had been debited with £3,854 10s. 9d. for the purpose of redeeming loans. The amount spent on capital account is £3,723 19s. 9d., and for part of this amount no sanction had been obtained from the Local Government Board, but application has been made for a sanction to cover this capital expenditure.

MANCHESTER.—At a meeting of the Corporation, Mr. G. Howarth, chairman of the Electricity Committee, proposed, "That the Council re-appoint Mr. S. L. Pearce, chief electrical engineer, for a period of six years on the following terms, viz.: salary for the first and second years at the rate of £1,300 per annum, for the third and fourth years at the rate of £1,400 per annum, and for the fifth and sixth years at the rate of £1,500 per annum, Mr. Pearce to enter into an agreement to remain in the employ of the Corporation for six years from February 1, 1912, and to devote the whole of his time to the duties of such position and in carrying out any electrical extensions or works in the future as may be required. Mr. Howarth said the Committee passed the resolution unanimously, and he pointed to the fact that Mr. Pearce was appointed deputy chief engineer in 1901 and had been the chief engineer since 1905. He called attention also to the progress made in the reduction of the cost of current and otherwise, to the additions made to the works under Mr. Pearce's direction, and said that not a penny had been paid for consulting fees. The resolution was carried, and the Committee's proposals approved.

MANCHESTER.—At a meeting of the South Lancashire District Centre of the Institute of Post Office Electrical Engineers a paper was read by Mr. W. Moon on "Short Distance Telephony." The paper dealt with the conversion of the energy produced in speaking into a telephone into mechanical, electrical, and back into mechanical energy. The lecturer stated that Siemens found that only one 10,000th part of the energy expended on the transmitter is reproduced in the receiver, and from the point of view of the transmission of power the telephone is at present a very inefficient piece of apparatus. It was pointed out that the improvements which had been made in receivers were very small, and that the instrument was in practically the same state as when it left the hands of Professor Graham Bell in 1876.

MARYLEBONE.—£2,650 is to be borrowed from the L.C.C. for the period of 12 years for storage batteries for the electricity undertaking.

MENAI BRIDGE.—After many delays there is a prospect of the electric lighting scheme propounded to the Urban District Council two years ago by Mr. E. Parry being shortly carried into effect.

SHERBORNE.—At a meeting of the Rural District Council formal consent was given to the application of Messrs. J. and W. Purves, of Exeter, for a Provisional Order to supply electricity throughout the whole of the urban district. Messrs. Purves intimated that they were prepared to enter into an agreement giving an undertaking:—(1st) To make good all streets broken up, to the satisfaction of the Council; (2nd) not to charge more than 3d. per unit for street lighting.

SKEGNESS.—At a meeting of the Urban District Council it was resolved, though not without some opposition, that expert advice should be obtained on the subject of promoting an electric lighting scheme and possibly an electric tramway scheme. The cost of a lighting scheme is estimated at £6,000.

SOUTHAMPTON.—The Electrical Engineer reports that the receipts of the electricity undertaking show an increase for the half-year ended September 30 last of nearly £2,700 over the corresponding period of last year, while the estimated increase up to March 31, 1912 was put at £2,837. Thus there was every reason to anticipate that at the end of the present year the income would be some £5,000 or £6,000 more than what it was in the previous 12 months It has been decided to apply to the L.G.B. for sanction to borrow £9,600, the estimated cost of providing additional plant for next winter's load. Such plant is to be the exact duplicate of that last installed. Application is also to be made to borrow £2,000 for motors, £1,000 for radiators, £3,500 for services, and £1,500 for meters.

STRATFORD.—The Urban District Council has decided to re-appoint Mr. T. L. Miller, consulting engineer, for one year, at a fee of 25 guineas to cover the following services: (1) conferences as may be necessary from time to time by the Electricity Committee or its chairman or its engineer; (2) quarterly preparation and submission of reports on the working of the station and condition of the plant.

SWANSEA.—Important tenders are about to be called for in connection with the extension of the electricity undertaking.

TRACTION NOTES.

BRIGHTON.—At a ratepayers' meeting held to consider the promotion of a Bill in Parliament for the establishment of a trackless trolley system, there were 59 votes in favour of the proposal and 53 against.

COVENTRY.—The Rt. Hon. Alfred Lyttelton, K.C., M.P., is to be the arbitrator in respect of the purchase by the Corporation of the undertaking of the Coventry Electric Tramways Company, Ltd. The hearing will take place in London at the beginning of next week.

ILFORD.—A sub-committee has been appointed to consider the question of interrunning the Council's trams with those of other local authorities. A further sub-committee has been appointed to consider as to the desirability of seeking Parliamentary powers to extend the present tramway system; to instal a system of railless traction, or to run a service of motor buses through Cranbrook-road and other parts of the district.

LEEDS.—The net revenue of the Yorkshire (West Riding) Electric Tramways Company for last year is stated at £19,037 after providing for debenture interest, a sum of £2,000 was brought forward, and after appropriating £7,465 for depreciation, renewals and general reserve fund, £13,571 has been written off preliminary expenses.

STOCKPORT.—Some opposition is being manifested to the proposal of the Corporation to promote a Bill in Parliament for a trackless tramway system between Stockport and Marple, by way of Offerton. The scheme would cost about £12,000. At a public meeting of ratepayers several speakers declared that the proposal would be a financial failure and that it would be better to develop existing routes, but the scheme was approved by a large majority.

TWICKENHAM.—The Highways Committee have decided to prepare a petition against the Southall, Hounslow and Twickenham Railless Traction Bill on the ground that there were several portions of Whitton-road unsuitable for railless traction unless widenings were effected; also that the protection clauses of the Bill required strengthening materially. When satisfactory clauses are obtained the opposition is to be withdrawn.

LANCASHIRE NOTES.

The Old Way and the New—The Design, Manufacture and Sale of Power Plant—Mr. Michael Longridge on Contractors and Engineers.

Presiding at the first meeting of the session of the Manchester Association of Engineers, Mr. Michael Longridge, the well-known chief engineer of the British Engine, Boiler and Electrical Insurance Company, delivered an unaugural address which will be read with special interest by electrical engineers. He drew, at the outset, a striking picture of past and present practice in regard to the relations between the proprietors of large works and the engineer. They knew nothing, and pretended to know nothing, he said, of the mysteries of engineering, and when special work was

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required, they called in the "family engineer" just as in other circumstances they might have called in the family doctor or the family solicitor. "They put themselves in his hands," said Mr. Longridge, "accepted his advice, took what he gave them, paid his bill, and usually were content. Much good work was done in this way, for the engineer was intimately acquainted with the requirements of his customer, his men knew every bolt and key about the customer's mill, time and first cost were not considered as they are now, and the engineering skill required to turn out a good job was less. On the other hand, progress was slow, for engineers, deferred to and uncriticised by their customers, became opinionated, intolerant of change, and antiquated in methods and designs." That era had passed away, and with it many old engineering firms whose prosperity was bound up in the customs of the time.

The new era embraced municipal committees and managing directors of joint stock companies and men who watched what their neighbours were doing and compared methods and costs. "If they were chary of giving information they were seldom backward in asking for it, and they had learnt that the world contained more than one firm of engineers who could do good work. The result was that work was now usually put out to tender, and had therefore to be described in more or less detail in specifications for the protection of both purchaser and contractor. The drafting of a clear, complete, and practicable specification was not," said Mr. Longridge, "by any means a simple matter. It demanded not only a theoretical knowledge of engineering, but an intimate acquaintance with workshop methods, and with the requirements of the trade in which the machinery to be tendered for was to be used. It was to careless drafting and to careless reading of specifications that most of the disputes between purchasers and contractors were due. Some of the larger joint-stock companies and corporations had in their service engineers of knowledge and experience, capable of drawing specifications and supervising work, but the majority had to depend upon consulting engineers, or upon the contractors who desired to tender for the work unless, as often happened, their directors elected to manage the business by such light as nature might have vouchsafed to them. In such a case the object aimed at is explained, so far as it is understood, to the representatives of several contracting firms who are asked to furnish plans and specifications showing how it is to be accomplished, together with estimates of the cost. Most of these plans are models of concise pictorial exposition, just what are needed to show clearly the main outlines of the schemes proposed, but the specifications are usually vague, abounding in such expressions as 'great strength,' 'ample capacity,' 'large bearing surfaces,' 'highest class of workmanship,' 'best materials,' and the like, but containing few dimensions or details of the accessories to be included in the contract price. The consequence is that the directors, who with the assistance of their manager and enginemen can generally understand the plans, are quite unable to compare the specifications or to decide (and small blame to them) which gives the best value for the tendered price. Then the contractors are recalled, and after much bargaining one of them is induced to accept the plan and specification which the directors consider most advantageous at or below the price quoted in the lowest tender."

There was no doubt that under this system orders could be placed at exceedingly low prices, but it was doubtful whether, on the whole, those who adopted it, got as good value for their money as others who employed professional advisers. "The contract prices are too often supplemented by bills for extras, and the completed work marred by makeshifts, especially if it consists of alterations of or additions to existing plant. The guarantees, if any, are found to be elusive because the conditions demanded for the tests are not to be obtained. It can hardly be otherwise when contracts are based on incomplete preliminary plans and specifications of the type referred to.

"And work done in this way oftens fails to satisfy, not because contractors are dishonest, but because purchasers do not know what they really need. The provision of insufficient power and the adoption of types of machinery unsuitable for the work to be done at the instance of men directing engineering work without engineering knowledge are within the experience of every contractor and consulting engineer. From the contractor's point of view also the practice is unsatisfactory. The preparation of preliminary plans, with the knowledge that except in rare cases they will not be paid for, and may even be handed over to a competitor to be carried out, takes all the pleasure out of the work, and too frequent quarrels over extras and final reductions of already cut prices, to get a settlement after the completion of the job, create disgust. Then there are other cases in which directors send the plans, specifications, and tenders received from the contractors to a consulting engineer, and ask him to advise which is the most advantageous. If the engineer keeps within the limits of his instructions, I do not think his employers benefit much. He can certainly tell them which of the plans submitted is the best from a purely engineering point of view, but whether that plan be the most suitable having regard to the local and trade conditions and possible future requirements he cannot tell. To decide these points usually requires information which contractors' plans and specifications do not give. The directors then make their bargain with the contractor selected and a more or less formal contract follows, which customarily provides that the consulting engineer shall inspect the plant during construction and certify that it is in accordance with the specification, but very often it is agreed that he shall also settle all details of the design. Sometimes the question of inspection is only raised after the contract has been signed. This I think is hardly fair, for even when the specification is perfectly definite and the inspector reasonable his presence causes some expense, and when the specification is indefinite and the inspector faddy the expense may be very great.

"The remedy fortunately lies in the contractor's hands. He can always find out if his work is to be inspected before he signs a contract, and if his specification be so indefinite that an inspector can put him to any great unforeseen expense he has no one but himself to blame. As an inspector under such a contract the position of the engineer is delicate and difficult. Some people seem to think that it his duty to become a mere tool for squeezing the contractor by interpreting the specification and contract solely in their own interest, by twisting every ambiguous expression to their advantage, and using every pretext their ingenuity can suggest for extracting work or money from him. I hope that no consulting engineer belonging to this Association will suffer his authority to be prostituted in this way. I maintain that it is his duty to hold the scales of justice fair, to see that his employer gets the thing the contractor has tendered for in workmanship, material, and design, but not to force the contractor into expenditure which he never contemplated when he made his tender, because the indefinite wording of the specification might be stretched to cover such expense.

"An engineer inspecting under an indefinite and ambiguous specification should have some regard to the price at which the work was taken, and the style of design and finish customary at the shop at which the work is done. Let me not be misunderstood. No consideration of this kind should induce an engineer to pass bad material, dangerous designs, or obviously insufficient strengths, but there are many matters of design and finish which are held to represent the best practice in some shops while classed as second-rate in others. But if it is difficult for the engineer merely to interpret an indefinite and ambiguous specification fairly, what is his position when he is held responsible for all details of the designs? I have been forced into that position more than once, and I say it is intolerable. To do justice to the contractor and to give satisfaction to his employer and to himself is well-nigh impossible. His experience, or if you prefer, his fads, which are the outcome of his interpretation of his experience, may constrain him to call for alterations of the contractor's usual designs, which may involve the latter in expenses never contemplated when he estimated for the work, and, at the same time, lead to mistakes and mishaps in execution which may seriously affect the efficiency of the plant, or even lead to its total failure, for a manufacturer forced out of his beaten track may easily lose his way. In every path the engineer may tread are pitfalls so carefully concealed that he who traverses the road for the first time is almost certain to stumble into one of them. Experience as well as knowledge is needed to ensure success in engineering."

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On the motion of Mr. W. Fox, ex-president, seconded by Mr. T. Ashbury, a hearty vote of thanks was accorded to Mr. Longridge, and then followed an interesting discussion of the paper.

GERMAN NOTES.

Tidal Action as Motive Power—Electric Railway Progress.

According to the "Berliner Tagblatt," an engineer named Pein has set himself the task of erecting a plant at Husum for generating power for Schleswig-Holstein by means of the ebb and flow of the tide. Pein has been studying the problem for a long time, and about three years ago he began operations between Husum and the solitary island of Nordstrand, in the North Sea. At present the island is being connected with the mainland by two gigantic reservoirs, a high water reservoir with an area of 1,500 acres, and a low water reservoir half as big again. The flow of water from these reservoirs will drive the turbines, and there will always be water in one or the other above the level of the sea at the time. The sludge from the reservoirs will be used as manure. The turbines will drive continuous current dynamos. The electrical works proper will be begun in the spring of 1912.

German Electric Railways.

The agreements between the City of Cologne and the A.E.G. and the Siemens Schuckert Werke in respect of an electric express line between Cologne and Dusseldorf are now completed. The next move lies with Dusseldorf. This city refused its adherence to the scheme in the teeth of the Government, be it said, unless the line was prolonged to the industrial centres beyond Dusseldorf. Should Dusseldorf prove obdurate after further negotiations, the line will be made without its assistance, crossing the Rhine by a new bridge at Neuss. The cost is expected to be about a quarter of a million sterling. A twenty minutes' service is contemplated. The line will be at first for passengers only, but goods traffic is included in the scheme, which will take two years to execute.

A new rapid electric line is likely to be constructed for the western suburbs of Berlin to supply the districts of Grunewald, Zehlendorf and Wannsee. Until it leaves the city itself the railway will be an underground line.

Breslau Electric Station.

This is to be enlarged at a cost of 300,000 marks.

Water Power at Agram.

Croatia is about to utilise the water power of the Save to supply electricity to Agram. The cost of the works, which will supply 12,000 h.p., is put at 3 million crowns, say £125,000.

Waste Heat from Electric Works.

Otto Goertz, writing in the "E.K.B.," calls attention to the great advantages to be obtained by associating public baths and wash-houses with large electric stations when the waste steam of the one can be used to heat the water of the other, or for central heating stations. In the former case 100,000 W.E. delivered to the baths in the form of water at 40° C. can be put at 4d. and in the latter case at 10d. With a water temperature of 75° and 3,500 working hours per annum, there will be a yearly income of about £6,600. The outlay for plant can be put at £720,000, so that after an annual writing off of 20% for depreciation and attention and including increased coal consumption, a net profit of about 100,000 K. is left. The writer thinks that it would be advantageous to make the profits of large power stations dependent on supplying heat for baths, factories and private houses, and the supply of current a bye-product only. He thinks that in this way great reductions in the price of the unit would inevitably follow.

AMERICAN NOTES.

A New Electrical League—The Need for Co-operation—Premium for Ideas—

Some noteworthy suggestions were put forward at a gathering of Pacific Coast Electricians which was held the other day at San Francisco with the object of securing a greater measure of co-operation among electrical interests in order to help the public at large to a better understanding of the advantages of electricity. Mr. Hanbridge, whose activities on behalf of the Electrical Contractors' Association are well-known on the Pacific slope, put in a strong plea for co-operation between the manufacturer, jobber, central station and contractor, and pledged the active support of the electrical contractors in furthering this plan. Mr. Glenn Webster, manager of the engineering department of the National Electric Lamp Association, gave the gathering an account of the work of similar electrical leagues in the East. One of the fundamental laws for success, he said, lay in giving the greatest good to the greatest number. In the electrical business this must include the consumer, perhaps the most essential element in the electrical body, and as such entitled to every consideration. "It is very true," he added, "that men who don't get together don't know each other. I believe it is a recognised fact that men who have striven alone if they have been able to rise to a position it was because there must have been a great amount of good in these men. If you will get together, if you will know each other and will honestly try to work out the problems that will come before you, you will say that unity is alright. It seems to me as we sit here," he continued, "that every man is a brother in the electrical fraternity and can go out and create public sentiment on the line of fundamental truth. Even this number of members could almost mould sentiment for electricity. How are you going to get at this? Any movement that amounts to anything takes a lot of work. It takes 'man hours.' If the Electrical League, if you would call it that, is going to work it is going to take 'man hours' to do it. You are going to get pay for those hours. When a man gets so busy that he can't attend to business he is going to drop out of the race. In order to get the fellows to work I say get them something to do. Committees should be appointed such as a public policy committee, street lighting committee, power committee, publicity committee, with the idea of having something for the fellows to do, so they would feel they were a part of the body. You bring out men you don't know in this way. It also lessens the work of the officers. With this viewpoint in mind I believe the field here is large." The response to these appeals was not only enthusiastic but immediate. An Electrical League was formed then and there, and a committee appointed, and in half-an-hour upwards of a hundred members had been enrolled.

An Electrical Ideas Department.

With the object of rendering the maximum of service to the central station manager, the electrical contractor, the dealer in electrical material and the manufacturer of current consuming devices, the "Electrical Review and Western Electrician," of Chicago, offers a premium for the ideas of its readers calculated to serve this end. In the central station department suggestions might be sent in respecting methods of introducing applications of electrical energy to every kind of industry, examples of co-operation with churches, business and civic organisations for demonstration and trial installations, street lighting, illuminated street parades, window dressing, special sign campaigns, and advertising and selling methods of every description. In the department devoted to the electrical contractor, suggestions are asked for respecting shop systems, estimating, wiring, construction methods, getting business, exposed conduit wiring, wiring with wooden moulding, wiring with flexible conduit and cable, wiring with iron conduit, new wiring in buildings already wired, wiring for alternating-current and direct-current service, wiring for signal systems, annunciator and bell systems, wiring for elevator service, both cage-controlled and automatically operated from floor landings. In the section devoted to dealers there might be suggestions respecting the handling of shelf material, warehouse stocks, ticketing of new material, follow-up systems as an aid to inventory and the elimination of dead stock, writing of orders, express service in the handling of small orders for a large variety of material, methods of packing fragile material to eliminate breakage, credits, etc. For the best idea sent in in any one week a premium of five dollars is offered, while for every item printed payment will be made at ordinary scale rates.

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Electrical Contractors' Section.

Contracts Open and Accepted, and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

CORPORATION OF DUBLIN.

The Electricity Supply Committee of the Corporation of Dublin are prepared to receive Tenders for the supply of

E.H.P. SUBSTATION SWITCHBOARDS AND ACCESSORIES.

Specification, with General Conditions and Form of Tender, can be obtained from the City Electrical Engineer, Electricity Works, Fleet-street, on and after Monday, 8th inst., on payment of one guinea for each specification, which will be returned on receipt of a bona fide Tender.

Tenders addressed "Chairman of Electricity Supply Committee, 3, Cork Hill, Dublin," and marked "Tender for E.H.P. Substation Switchboards, etc.," to be received not later than noon on Thursday, the 18th inst.

The Corporation do not bind themselves to accept the lowest or any Tender, and reserve the right of accepting a Tender for any section separately if found desirable.

FRED. J. ALLAN,
Secretary.

Electricity Supply Committee,
3, Cork Hill, Dublin.
January 6, 1912.

APPOINTMENTS.

URBAN DISTRICT OF ERITH.

APPOINTMENT OF ASSISTANT ELECTRICAL ENGINEER.

The Urban District Council invite applications for the appointment of Chief Assistant Electrical Engineer, at a salary of £200 per annum.

Applicants must be thoroughly capable Electrical and Mechanical Engineers, with actual operating experience of a three-phase high tension system, and be accustomed to the sole control of workmen.

Full particulars and forms of application may be obtained from the undersigned on receipt of a stamped, addressed foolscap envelope.

Applications endorsed "Assistant Electrical Engineer," must reach me on or before Wednesday, the 24th instant.

J. KENNEDY ALLERTON,
Clerk and Solicitor.

Council Offices,
Erith, Kent.

CITY AND COUNTY OF BRISTOL.

ELECTRICITY DEPARTMENT.

The Electrical Committee of the City of Bristol have a vacancy for a sub-station shift engineer and will be glad to receive applications for the same.

Applications, giving age and details of training and experience, with copies of not more than three recent testimonials, to be forwarded to the undersigned not later than Thursday, January 25.

The salary will be at the rate of 30s. per week, rising to 35s. if the services are satisfactory.

Previous E.H.T. sub-station experience absolutely essential.

H. FARADAY PROCTOR, M.Inst.C.E., M.Inst.E.E.
Engineer and General Manager.

Exchange, Corn-street,
Bristol.

WANTED by a firm of large dynamo manufacturers in the Manchester district, juniors for the Designing, Engineering and Contracts Departments. Applicants must have had good technical training and experience. Commencing Salary 35/- per week. Apply Box D.E.C., ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

Contracts Open.

HOME.

ASHTON-UNDER-LYNE.—The Electricity Committee of the Corporation invite tenders for three Lancashire boilers and two 1,500 kw. turbo-alternators. Particulars (£1 1s. each) from the Borough Electrical Engineer. January 24.

BURNLEY.—The Board of Guardians invite tenders for the supply of a lighting battery at the Workhouse. Particulars from Mr. J. S. Horn, Union Offices. January 24.

BURTON-ON-TRENT.—The Corporation invites tenders for the supply and erection of the following plant, etc., for the Electricity Department:—Specification No. (12) one 1,950 kw. turbo-alternator and condenser; (13) switchboard and gallery; (14) one 500 kw. motor-generator, one 300 kw. motor-generator; (15) water-tube boiler, stoker and superheater; (16) superheaters; (17) steel stack; (18) economisers; (19) mains. Particulars (£1) from Mr. Thos. Hall, Borough Electrical Engineer. Guild-street. January 27.

CROYDON.—The Corporation invite tenders for the supply of a mixed pressure turbine plant at the electricity works, Factory-lane. Particulars (£1 1s.) from the Borough Electrical Engineer. January 29.

DARTFORD.—The Urban District Council invite tenders for the supply and erection of (a) one uniflow high speed vertical engine, tandem generators, and 3-wire balancer; (b) three superheaters and extensions to pipe work; (c) switchboard; (d) electrically driven centrifugal pump. Particulars, £2 2s, from Mr. J. D. Pember, Electrical Engineer. January 23.

DUBLIN.—The Port and Docks Board invite tenders for the supply of two 4-ton electric Portal wharf cranes. Particulars (£1) from Sir J. P. Griffith, M.Inst.C.E, East Water, Dublin. January 30.

EXETER.—The Visiting Committee of the Asylum invite tenders for the supply of (a) steel conduits and fittings; (b) vulcanised rubber cables; (c) distribution fuse boards, distribution switch and fuse boards. Particulars from the Clerk, 8, Southernhay West, Exeter. February 2.

HORNSEY.—The Corporation invite tenders for the extension of the Temperley transporter. Particulars (10s. 6d.) from the Borough Electrical Engineer. January 25.

KENDAL.—The Corporation invite tenders for the supply of one 100 kw. direct-current steam generating set. Particulars from Mr. J. A. T. Barnes, Borough Electrical Engineer. February 1.

NUNEATON.—The Corporation invite tenders for the supply of one 500 kw. mixed pressure turbo-generator with condensing plant and pipework, etc. Particulars (£1 1s.) from Mr. S. C. Gibson, Borough Electrical Engineer. January 24.

STEPNEY.—The Borough Council invites tenders for the supply and erection complete of one e.h.t. converting plant, suitable for 6,000 volt three-phase a.c. to l.t.d.c., together with e.h.t. and l.t. switch-gear, etc. Particulars from Mr. W. C. P. Tapper, A.M.I.E.E., borough electrical engineer and manager, No. 27, Osborn-street, Whitechapel, E., upon receipt of a deposit of five guineas (returnable). January 29. See official notice in last week's issue.

OVERSEAS.

AUSTRALIA.—Tenders will be received by cable at the office of the Deputy Postmaster-General, Sydney, up to noon on January 24, for the supply of 100 circular nuts and 5,000 protectors (Schedule No. 124); by the Deputy Postmaster-General, Hobart, up to noon on February 19, for the supply of a wire-testing machine (Schedule No. 37); and up to noon on February 26, for the supply of 5 miles of vulcanised indiarubber insulated, lead-covered, etc. cable (Schedule No. 35). A deposit of 5% on the first £1,000, and of 2½% on the amount above that sum, is required with each tender. Local representation is necessary. For copies of the specifications and forms of tender, application should be made to the High Commissioner in London for the Commonwealth of Australia, 72, Victoria-street, S.W., where also preliminary deposits may be paid.

BILBAO.—With reference to the call for tenders for the filtration and sterilisation of the water supply of Bilbao, H.M. Consul at that place (Lord H. Hervey) reports that the time for the

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receipt of tenders has been extended to noon on February 1. Tenders should be addressed to the "Secretaria del Excmo. Ayuntamiento," Bilbao.

CONSTANTINOPLE.—Tenders will be received at the "Ministère des Travaux Publics," Constantinople, up to February 20, for a concession for the supply of electric light and power to the town of Adalia, which has a population of some 30,000. The supply of power for telegraph and telephone installations and electric traction is excluded from the concession. Power is to be generated from waterfalls. Tenderers must supply proof of technical and financial competency, and a deposit of £T250 (£225) is required with each tender. Local representation is practically indispensable in the case of Turkish Government contracts. A list of British commission agents established in Constantinople may be obtained by British firms on application to the Commercial Intelligence Branch of the Board of Trade.

NAPIER, N.Z.—Tenders are invited by the Corporation of Napier, New Zealand, for electric tramway, lighting and power works as follows:—Contract No. 2.—Permanent way, road and sewer alterations, overhead work and supply mains. Contract No. 3.—Power station, car shed, and repair shop equipments. Contract No. 4.—Rolling stock. Tenders will be received by the Town Clerk, Napier, up to March 7. A deposit of 2½% of the value of the offer must accompany each tender. Copies of the plans and specifications may be seen by British contractors at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

ITALY.—The "Gazzetta Ufficiale" notifies that tenders will be received, up to February 17, at the office of the "Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Piazza Municipio 37," Naples, for the supply and erection of machinery and apparatus, as well as hydraulic, electric and general accessories required in connection with the central electric generating station in Naples. The upset price is put at 1,230,000 lire (£49,200) and a deposit of 25,000 lire (£1,000) will be required to qualify any tender. Twenty months are allowed for the supply of the material. The energy to be generated at the Volturno Springs and carried into Naples will amount to 12,000 kw. a., and the plant must have a capacity for the production of a further 12,000 kw. a., if required. This contract is open to foreign competition, but all documents appertaining thereto must be made out in Italian. Plans and specifications governing the contract may be seen at the above-mentioned office in Naples.

MOROCCO.—The British Consul-General at Tangier (Mr. H. E. White, C.M.G.) reports that the Moroccan Adjudications Commission intend to make a contract, by private arrangement after competition, for the supply and delivery of two steam engines and of electric lighting plant, for an engineering workshop to be established at Tangier for the repair of lighters, etc. Applications from firms desirous of tendering will be received by "M. le Président de la Commission Générale des Adjudications et des Marchés, Dar En Niaba," Tangier, up to February 5. A copy of the general regulations (in French) may be seen by British manufacturers at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

PORTUGAL.—Tenders, made out in Portuguese, will be received up to March 2, at the offices of the "Conselho de Administraçao do Porto de Lisboa," Lisbon, for the supply of 10 electric cranes, in accordance with the specifications which may be seen at the above-mentioned offices. A deposit of 1,500 milreis (about £300) will be required to qualify any tender, which amount must be increased by the successful tenderer to 7% of the accepted price. Each of the 10 cranes must have a lifting capacity of 1,500 kilogs., but four of them must also be capable of lifting material up to 3,000 kilogs. in weight. Competitors other than Portuguese must enclose with their tender documents viséd and registered at a Portuguese Legation or Consulate testifying their willingness to abide by the Portuguese law should any dispute arise in connection with the contract.

Tenders Accepted.

DARLINGTON.—Supply and erection of 500 kw. direct-current dynamo coupled to reciprocating steam engine for the Corporation. Dynamo: The British Westinghouse Electrical and Manufacturing Company, Ltd. Engine: Messrs. Browett Lindley & Company, Ltd.

SHEFFIELD.—Plant, etc., for Corporation Electricity Department. Turbo-alternator: Messrs. Willans & Robinson, Ltd., £21,707; cables, lamps, switchboard, etc.: Dewhurst's Engineering Company, Ltd., £2,839; electric lighting, sewage work extension: Messrs. Browett, Lindley & Company, Ltd.

LOWESTOFT.—Supplies to the Corporation Electricity Department:—Motors: The British Thomson-Houston Company, Ltd.; meters: Messrs. Seimens, Ltd.; carbon lamps: The Ediswan Company, Ltd.; metallic filament lamps: The Electrical Company. The Corporation has accepted the tender of the British Westinghouse Electric and Manufacturing Company, Ltd., for a supply of 12 in. gear wheels with 4 in. bore at £2 12s. 6d. each.

That Worried Look

is caused by the Printing account he is inspecting, and the fact that despite its size he has had no benefit from it. Frankly, he could not look otherwise, because he has not had his work done by us. Our customers pay their bills cheerfully, for they get satisfactory results and increased trade from the use of our work. Remember—"Smiths' Printing Produces Purchasers," so don't wear a worried look, try us as a cure.

PRINTERS OF THE ELECTRICAL ENGINEER.

SMITHS' PRINTING CO. (LONDON & ST. ALBANS), LTD.,

Head Office and Works:

28-32, HUTTON STREET, WHITEFRIARS, E.C.

Telephones: 1030 Holborn. 13055 Central.
Telegrams: "Printable, London."

Country:

FLEET WORKS, ST. ALBANS.

Telephone: 31 St. Albans.
Telegrams: "Printable, St.Albans."

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MARYLEBONE.—The Borough Council has accepted the tender of Messrs. Babcock & Willcox, at £480, for two internal superheaters for boilers at the electricity works.

LONDON.—The Metropolitan Asylums Board has accepted the tender of Messrs. W. J. Fryer & Company, and Rhodes Motors, Ltd., at £36 5s. for extensions to the electric lighting at Queen Mary's Hospital, and at £28 1s. 6d. for the installation of larger motors to drive the mechanical stokers at Queen Mary's Hospital, respectively.

SOUTHWARK.—Cable for Borough Council's Electricity Department, 50 yards, 1·0: The British Insulated and Helsby Cables, Ltd., £62 7s. 10d.; 220 yards, 023: The Western Electric Company, £16 3s.; 440 yards, ·05: The Western Electric Company, £66.

Openings for Trade.

AUSTRIA-HUNGARY.—It is proposed to erect during the current year a central electric generating station in Siersza, for the purpose of supplying all the larger works and mines in the vicinity with electric power.

CANADA.—Information has been received from the Imperial Trade Correspondent at Toronto (Mr. F. W. Field), regarding certain public works which will probably be undertaken during 1912 by various municipalities in the province of Ontario. Waterworks, sewerage systems, street lighting, and electric power plants are included. It is further reported that the municipal council of a town in Manitoba is prepared to consider applications from companies which would take charge of its water supply, electric light and power, and street car systems. It is also announced that a report has been made by an engineer to an Alberta municipality with regard to three water-power sites near the town. At the most suitable of these, assuming a discharge of 500 cu. ft. of water per seceond, 1,100 theoretical h.p. would be developed with a 20 ft. fall; at high water, with a cubic discharge of 2,500 cu. ft. per second, 5,600 theoretical h.p. could be obtained. The installation of hydro-electric works is contemplated. The addresses to which communications should be sent regarding the above, may be obtained by British manufacturers on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

CONGO STATE.—The "Moniteur Belge" states that the extraordinary expenditure to be included in the Congo budget amounts to 18,618,660 francs, of which 40,000 francs are for the erection of telephone lines, and 1,700,000 francs for the establishment of wireless telegraph stations.

NETHERLANDS.—The British Consul at Rotterdam (Mr. H. Turing) has furnished information with regard to an electro-benzine and a steam tramway which it is proposed to construct in the Netherlands. Further particulars may be obtained by British manufacturers and contractors on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

NEW ZEALAND.—A report from the office of the British Trade Commissioner for New Zealand states that the Council of a New Zealand municipality have under consideration a scheme for the installation of electrical power plant for tramway working, house and street lighting, drainage and water works pumping, and general industrial uses. It is proposed to equip the station with Diesel oil engines. The proposal involves the flotation of a loan of about £11,000.

SPAIN.—An official notice issued by the Ministry of Fomento intimates that a concession has been granted to Don Gonzalo Hernandez y Perez-Medel for the construction and working of an electric tramway from Renteria to the French frontier.

Diary.

FRIDAY, JANUARY 19.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Northampton Institute. "Reinforced Concrete Construction," by Mr. W. Hislop, 5.45 p.m.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—St. Andrew's Hall, Glasgow. The "James Watt" Anniversary Dinner.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Students Section).—Paper, "The Testing of Iron," Mr. J. S. Nicholson, B.Sc., 8 p.m.

BATTERSEA POLYTECHNIC.—Battersea Park-road. "Illumination and its Measurement," by Mr. J. S. Dow, 7.30 p.m.

SATURDAY, JANUARY 20.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the works of the Western Electric Company, Ltd., Woolwich; train leaves Fenchurch-street at 8.53 a.m.

TUESDAY, JANUARY 23.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students Section).—Paper, "Electricity in Mines," Mr. J. Parkinson, 7.30 p.m.

"YIELD POINT" AND "ELASTIC LIMIT."

A further report to hand this week from the Engineering Standards Committee gives standard definitions of the terms "yield point" and "elastic limit." The former, specified as "the point where the extension of the bar increases without increase of load," is defined as follows: "the yield point is the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger." To this is appended this note: "A steel test piece at the yield point takes rapidly a large increase of extension amounting to more than 1-200th of the gauge length. The point is strongly marked in a stress-strain diagram." The Elastic Limit is defined as "the point at which the extensions cease to be proportional to the loads. In a stress-strain diagram plotted to a large scale it is the point where the diagram ceases to be a straight line and becomes curved," and it is added that "the Elastic Limit can only be determined by the skilful use of very delicate instruments and by the measurement of the extensions for small successive increments of load. It is impossible to determine it in ordinary commercial testing." In a note added by request of the Ships Committee, it is remarked that the Committee does not recommend the use of either "Yield Point" or "Elastic Limit" in the standard specifications for ship material, because in regard to the ascertainment of the Yield Point there is considerable divergence of opinion as to the best method of determining it, and all methods involve greater time and care than can be expected in the works. While it is possible in works by careful testing at a greatly reduced speed to obtain the Yield Point in ordinary mild steel and wrought iron, some of the harder steels and other constructional materials have no definite Yield Point at all, and some have no Elastic Limit. Further, it is quite impossible to determine the Elastic Limit in the time available for ordinary commercial testing. In its determination a specially delicate and accurate extensometer must be used, in the hands of a careful and competent observer, and the determination for each test bar would require a considerable time. It is properly a matter to be left to laboratories organised for scientific purposes. The Ships Committee is therefore of opinion that the present method of fixing, by experience, the working stress for any material as a proportion of the ultimate breaking stress rather than as a proportion of the Elastic Limit or Yield Point, is the best practical method, and it considers that the inclusion in the British Standard Specifications for ship material of tests to ascertain either the Elastic Limit or the Yield Point would not justify the dislocation of the ordinary commercial testing as carried out in the works' test rooms which would thereby be entailed.

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PUBLICITY SECTION.

Notes on Novelties, Trade Specialities, New Catalogues and Lists, &c.

Messrs. Berry, Skinner & Company.

Two of the most recent of the lists issued by Messrs. Berry, Skinner & Company, whose head offices in London are at 78, Upper Thames-street, give illustrated particulars and prices of Fool-proof Motor Starting Panels made up of their "Masta" type fused-switches and rheostat on angle iron framework, and also of their "Micaloc" enclosed switch without fuses. These lists are respectively Nos. 11011 and 2101. A special feature of the "Masta" enclosed fuses is that they possess an inverse time limit, and while acting noiselessly and instantaneously upon dead short circuit will blow with a time interval which is inversely proportionate to the excess current. As the fuse blows, the action of the arc upon the special filling forms a flux with a constantly increasing resistance, which gradually and noiselessly damps out the arc to extinction. It is pointed out that the use of open type copper fuses on motor circuits is rapidly becoming obsolete. A heavy overload or short circuit will cause a violent discharge of volatilized metal, and the surrounding vapour will carry the arc to the adjacent conductive surface. There is, however, a further consideration why bare copper wires should not be used for fusing purposes, viz., the high point of volatilization of this metal. Copper melts at 1090° C while zinc fuses at 418° C. and lead at 320° C. The high temperature of molten copper is liable to ignite any inflammable matter with which it comes in contact; moreover, an open copper fuse oxidizes rapidly in the presence of moist air, and rapidly deteriorates.

Messrs. Geipel & Company.

Messrs. Wm. Geipel & Company, of Vulcan Works, St. Thomas-street, London, S.E., report that the results of their trading for the year 1911 have shown a considerable increase on 1910, and, in fact, upon any year since they took over the business of Messrs. Paterson & Cooper. They have been particularly busy in their cable and carbon departments, as well as in the works which they have equipped for turning out high-class motor controlling apparatus. Considerable success has also attended the sale of their new time switch, of which the Manchester Corporation alone have over 100 in use. Further improvements have been made in Henrion carbons, particularly in their flame carbons, with the result that the business in the latter has shown a very substantial increase. Yearly contracts have been obtained from some of the leading local authorities using flame arc lamps as well as from various of the most important industrial concerns. Judging from the enquiries they are receiving and the general tendency, the prospects are that 1912 will be still better than 1911. Their new "Rapidity" steam trap appears to be meeting with the approval of users, and the month of December brought them a larger number of orders than they have ever had in one month before.

St. Helens Cable Company.

The St. Helens Cable and Rubber Company, Ltd., of Warrington, are sending out to their customers some rather striking illustrated cards in colour advertising their cab-tyre sheathing for the protection of cables. The back of the card contains some valuable data for easy remembrance relating to cables, current wiring, etc., and giving the cost per lamp under eleven different heads of complete installations.

Union Electric Company, Ltd.

List No. 5025, which has just been issued by the Union Electric Company, Ltd., of Park-street, Southwark, London, S.E., gives details and prices of a complete range of direct-current motors from ¼ to 50 h.p. adapted to every purpose and suitable for all pressures up to 550 volts. These motors are stocked in the open, protected, enclosed, ventilated and totally enclosed type, either series or shunt-wound, and before being sent out, all motors are tested under a high alternating pressure for leakage and latent faults. Prices range from £6 5s. upwards, and all goods carry the company's standard guarantee for workmanship and material.

The Benjamin Electric Ltd.

A new catalogue and price list of the Holophane-Benjamin Steel line of Reflectors for Industrial Lighting has been prepared by the Benjamin Electric, Ltd., and copies will be sent to the trade on application to the company's offices, 117, Victoria-street, Westminster. These reflectors are designed to fulfil the long-felt want of reflectors for the lighting of mills, factories, workshops, dockyards and railway stations, and have proved most efficient and satisfactory. They consist of five types, four of which are for pendant use in four different sizes with lamps from 17 to 300 watts, while the fifth type, which is parabolic in three styles, is designed for local lighting with small watt lamps, say from 17 to 35 watts. These reflectors are for use with the ordinary shade carrier lampholder, and no gallery is required, or they can be supplied equipped with the "Benco" weatherproof lampholder, making a most satisfactory and efficient line for outdoor work. They are entirely British made, and are covered by patents and registrations and pending applications.

"Korfund" Foundation Plates.

A new booklet to hand from the Korfund Company, of 47, Victoria-street, Westminster, gives details of the "Korfund" patent resilient cork plates for engine and machine foundations for the effective insulation of Diesel engines, gas engines, dynamos, rotary converters, etc. So as to absorb vibration and noise and prolong the life of machinery, these resilient plates are constructed by a patent process of strips of specially selected natural grown cork, which are so treated as entirely to preserve their elasticity. The strips are then bound securely together in iron frames which are strengthened with iron struts. The plates are made in various sizes, and such a number supplied for each individual order as will, when placed end to end and side by side, cover the entire area of the foundation bed. The average size of each section of the standard plates is one square foot. The frame acts as a support to each section of the plate and assists the resiliency of the cork. In addition to this, the millions of pores in the cork act as so many pneumatic cushions and take the pressure of the foundation both individually and collectively. "Korfund" plates, it is claimed, will not crumble, decay, nor become disintegrated, but will always retain their natural elasticity. They are made in two thicknesses, 1½ inch at 5s. 6d. per square foot and 2⅜ inch at 7s. per square foot. A list of power stations, factories, etc., where "Korfund" mats have been installed with complete success will be sent on application to the company.

Graham's Loud-Speaking Telephones.

Messrs. Alfred Graham & Company, of St. Andrews Works, Crofton Park, London, S.E., have issued for 1912 a strikingly handsome book of some forty pages giving a list of the ships which are now fitted with this firm's well-known loud-speaking naval telephones. The volume is profusely illustrated with finely printed photographic reproductions of these vessels, including all the latest types of British warships (nearly 400 of which are equipped with Graham telephones), numerous examples of foreign warships, and various types of British liners. The Graham system is recognised as the standard for vessels of every description, and in addition to the British Admiralty, the Graham loud-speaking telephones have been adopted by the navies of France, Russia, Italy, Portugal, Greece, Turkey, Japan, China, Denmark, the Netherlands, the Argentine, Brazil, Chili and Peru, as well as by some forty great shipping lines.

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The Curtis Manufacturing Company.

The M. and C. Manufacturing Company, of Conduit-place, Paddington, London, W., will in future be known as the Curtis Manufacturing Company, electrical manufacturing engineers. Their speciality is resistances of constant rating for all purposes, and especially for cinematograph work.

Car Meters.

We understand that Chamberlain and Hookham ampere-hour car meters are being installed on the Delhi trams. Messrs. Venner & Company have also received an order for 21 meters to equip the Ilford cars. The Nottingham Corporation intend to instal their type of meter on their cars, and have given an order for the first hundred.

ELECTRICAL TRADES' NEW YEAR'S GIFTS.

THIRD NOTICE.

Messrs. Neale and Wilkinson, Ltd., shipping, forwarding and insurance agents, of 32, St. Mary Axe, send an effective weekly tear-off calendar combined with important information relating to about one hundred of the world's great commercial centres. This embraces the difference in mean time, period occupied in conveyance of mails, transit of mail steamer, transit of cargo steamer, etc., to ports in both the Eastern and Western hemispheres.

From the Pope Electric Lamp Company, Ltd., we have received an extremely taking and effective advertising device in the shape of a perpetual calendar fashioned in the shape of their well-known sign, the lighthouse, and bearing their "slogan," "A Light Way to a Light House." Changing

the dates, days of the week, and months, is effected by means of an ingenious combination of cardboard discs, and the calendar is constructed either to stand on a desk or hang on the wall. Messrs. Pope will be pleased to send one of these calendars to any of our readers on receipt of trade card or business heading.

The Submarine Signal Company, of Friars-house, New Broad-street, E.C., issue a very artistic calendar in the shape of twelve tinted cards in a twin-cut mount, the upper half showing a variety of striking seascapes and shipping pictures illustrative of installations of the Company's Submarine Bell, while the lower half gives the calendar for the months.

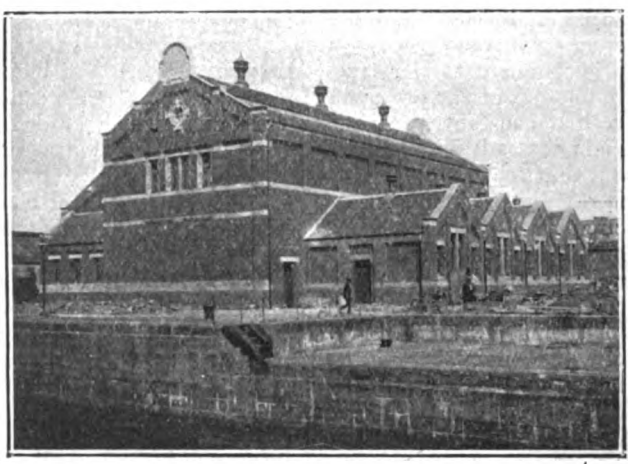
At Darmstadt, electric lighting has been supplied gratis for a time to many houses, with the result that the owners of them, being convinced of the superiority of the electric lamps both in cost and in illuminating power, have decided in the majority of cases to continue the electric lighting after the period of grace had expired. The town of Gothenburg is making some surplus current for house warming. This applies particularly to night work, when no current is needed for power.

LEITH DOCKS POWER STATION.

The new power station at the Docks, Leith, is a large building occupying a site between the Imperial and the Albert Docks. Hitherto lighting and power were obtained from the town supply station, but the Dock Commissioners decided to increase the uses to which electricity is put at present in and about the quays and sheds.

Three suction gas plants have been installed by the National Company, and two engines, each of 450 h.p., and are now in working order.

Messrs. Bruce Peebles & Company, Ltd., electrical engineers, Edinburgh, supplied the electric plant, consisting of two generators, each of 300 kw. capacity, 500 volts, when running at the engine speed of 300 revs. per minute.



The machines are of the Bruce Peebles standard open shunt-wound multipolar commutation pole type, each machine being fitted with one bearing, half-coupling and horse-shoe shaped bedplate for direct coupling to the National engines. These generators are capable of withstanding an overload of 10 per cent. for two hours at a time.

Hydraulic power has been mainly relied upon by the Leith Dock Commissioners for coal shoots and dock gates and capstans, but the introduction of an electric coal crane proved so satisfactory that electric power is gaining favour. Callender cables are being used for the dock's purposes.

PERSONAL.

The Committee of the City and Guilds Technical College, Finsbury, have appointed Mr. J. K. Catterson-Smith to be chief assistant to the Professor of Electrical Engineering.

Mr. G. T. Symons and Mr. C. G. Tegetmeier have been appointed to fill the vacancies on the board of the British Electric Traction Company Ltd., till the next annual general meeting.

Mr. F. Douglas Watson, late provincial superintendent for the National Telephone Company in Scotland, who has been appointed general manager and secretary of the Société Anonyme Ottomane des Téléphones de Constantinople, left Paris by the Oriental express on Saturday last, to take up his duties in Constantinople.

Arising out of the successful electrical trades London to Brighton walking race which was held last year and in which H. E. Purnell, of the General Electric Company, won the Osram Cup, it has now been decided to form two walking clubs, one in the North of London (Hackney Walking Club) and the other in the South of London (Clapham Walking Club), of both of which particulars can be obtained from the respective secretaries, namely, Mr. S. C. Haynes, 20, Penda-road, Clapton Park, London, and Mr. A. R. Edwards, 47, Courtenay-road, Merton, London. Training quarters are being arranged for in both districts and a programme of suitable strolls and races will be fixed up shortly.

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British Westinghouse Electrical and Mfg. Co., Manchester.
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eld Bros., 25, Rudge Row, Cannon Street.

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Phillips Commutator Grinders Co., Ltd., 27, Walbrook, E.C.

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Willans & Robinson, Victoria Works, Rugby.

Conduits.
Flexible Metallic Tubing Co., Ponders End, Middlesex, & 112, Queen Victoria-street.
General Electric Co., 71, Queen Victoria-st
Metallic Seamless Tube Co., Wiggin-street Birmingham.

Coppersmiths.
Andrews, R. W., & Co., 148-150, Pentonville-road, London, N.
Dore, J., & Co., High-st., Bromley-by-Bow.
Harvey, G. A. & Co., Lewsham, London, S.E.

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Aerators Limited, "Prana" Sparklet Works, Upper Edmonton, London, N.

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British Prometheus Co., Ltd., Salop-street Works, Highgate, Birmingham.

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General Electric Co., 71, Queen Victoria-st.
Lundberg, A. P., & Sons, Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Metallic Seamless Tube Co., Wiggin-street, Birmingham.

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Edison & Swan United Electric Co., 36 & 37, Queen-street, Cheapside.
General Electric Co., 71, Queen Victoria street.
Gibbs, J. & Son, 72-76, Duke-street, Liverpool.

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British Prometheus Co., Ltd., Salop-street. Works, Highgate, Birmingham.
Bastian Electric Heating Syndicate, Ltd., 91-93, Palmerston House, E.C.

Electric Light Contractors.
British Thomson-Houston Co., Rugby.
Ferranti Limited, Hollinwood, Lancs.
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Johnson & Phillips, Old Charlton, Kent.

Electric Light Fittings.
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Electric Locomotives.
British Thomson-Houston Co., Rugby.

Electric Radiators.
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.
Dowsing, 105, Gt. Portland St., W.

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British Westinghouse Electrical and Mfg. Co., Manchester.
Ferranti Limited, Hollinwood, Lancs.

Electric Signs.
Caspar Signs Co., 33, Kings-road, St. Pancras.

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Willans & Robinson, Rugby.

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Dore, J., & Co., High-st., Bromley-by-Bow.
Harvey, G. A., & Co., Lewisham, London, S.E.
Willcox & Co., 36, Southwark-street, S.E.

Engineers' Stores.
Willcox & Co., 36, Southwark-street, S.E.

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Wilkinson, Geo., Beech Mount, Harrogate.

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Merryweather & Co., Greenwich, S.E.

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Johnson & Phillips, Old Charlton, Kent.

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British Westinghouse Electrical and Mfg. Co., Manchester.
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Union Electric Co., Park-street, Southwark, London, S.E.

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Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
General Electric Co., 71, Queen Victoria-st.

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General Electric Co., 71, Queen Victoria-st.
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British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.

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Dorman & Smith, Ordsal Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.

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Harvey, G. A., & Co., Lewisham, London, S.E.

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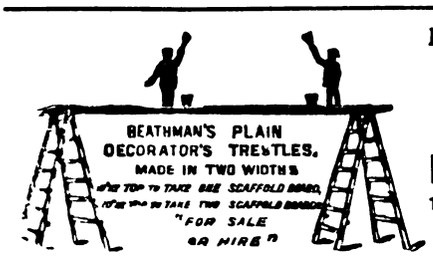

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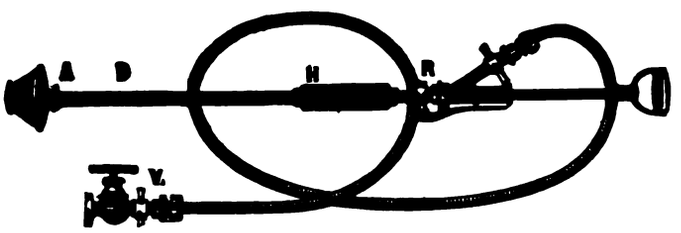

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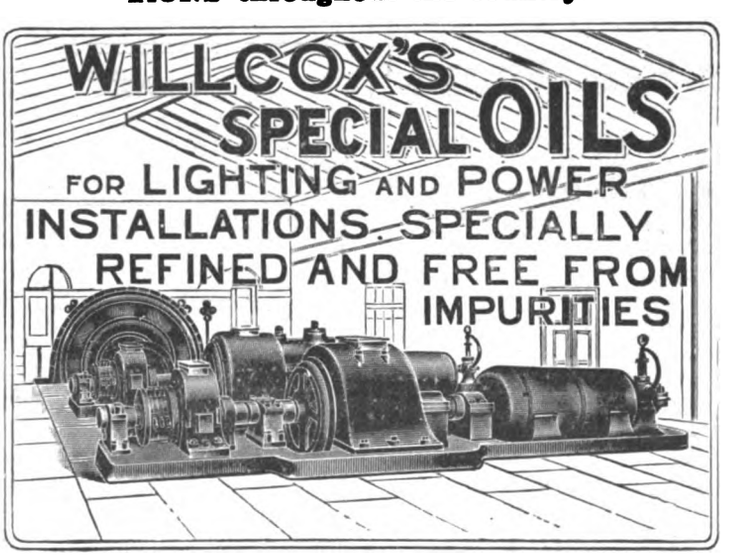

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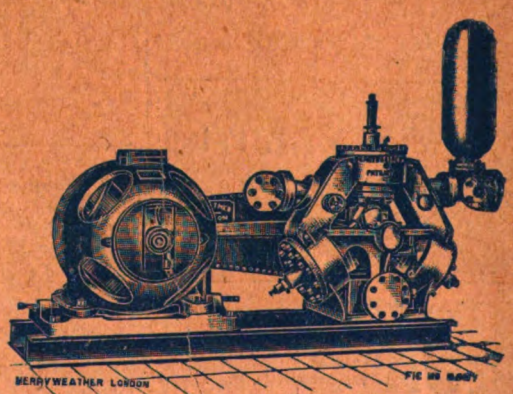

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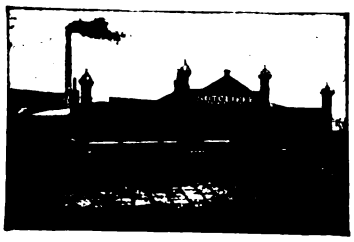

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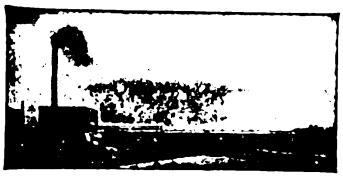

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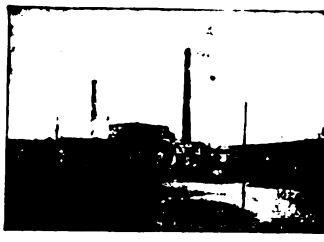

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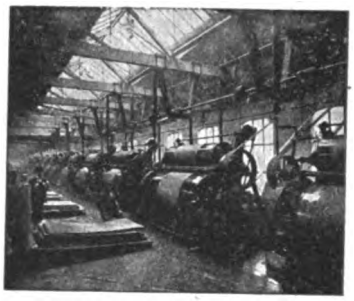

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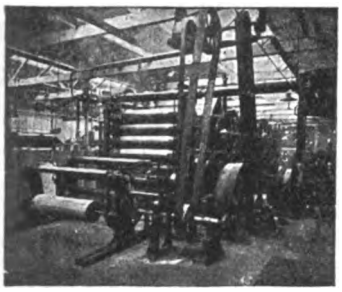

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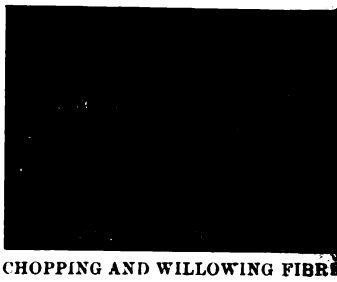

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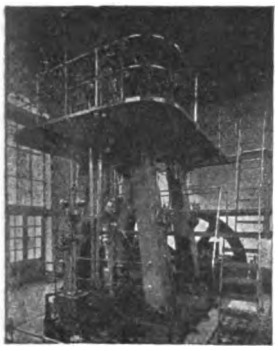

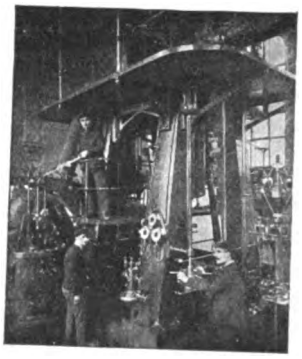

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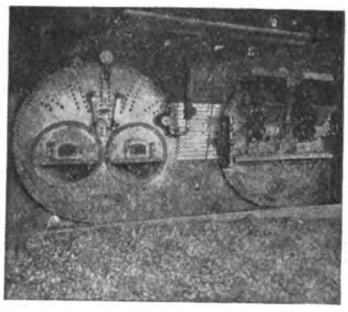

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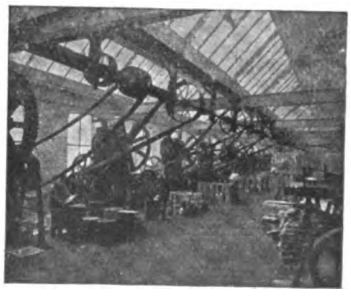

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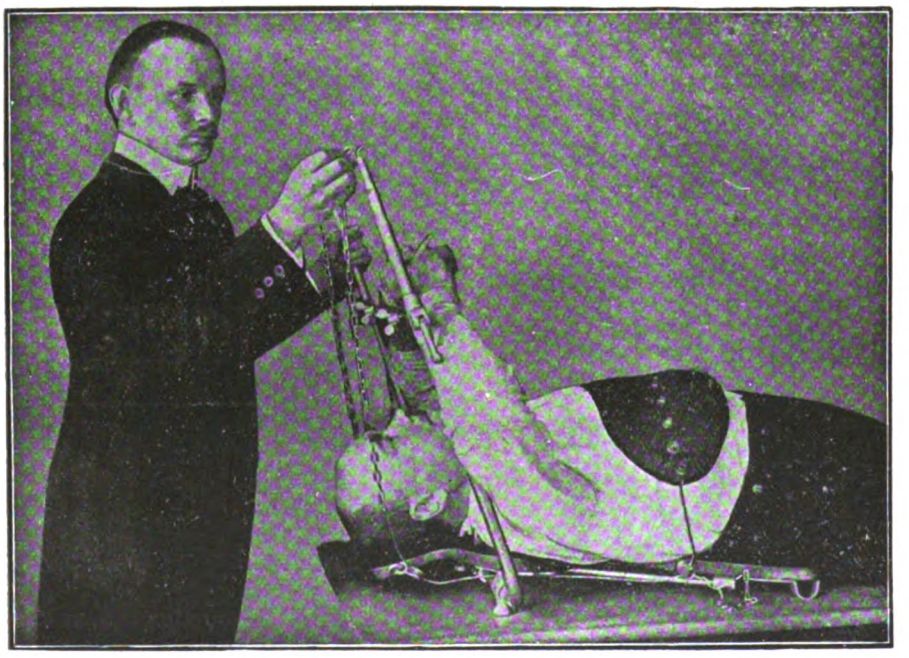

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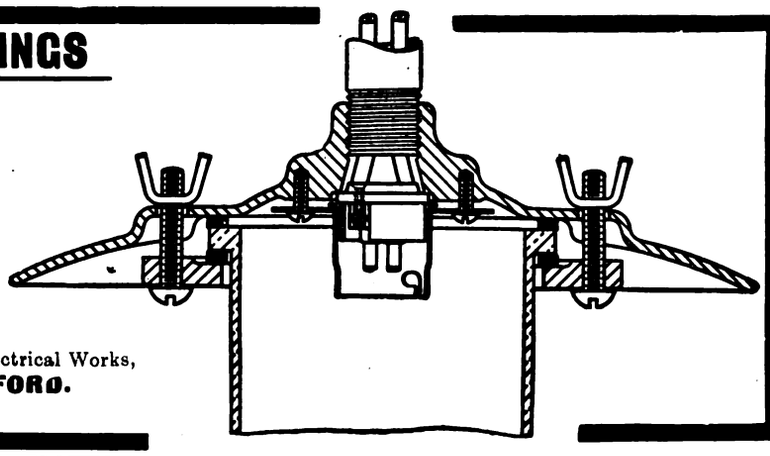

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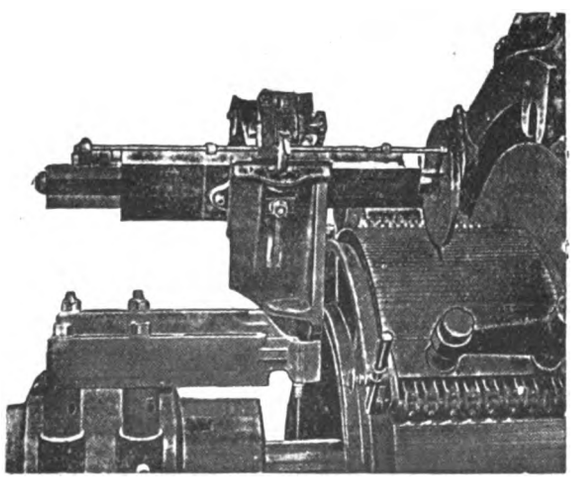

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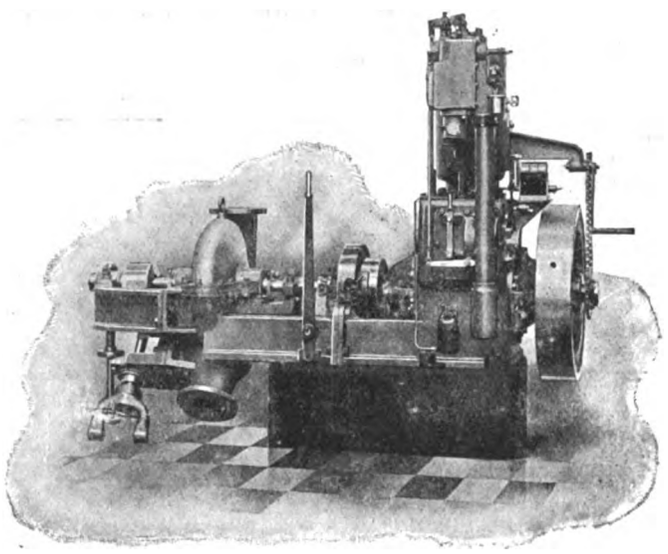

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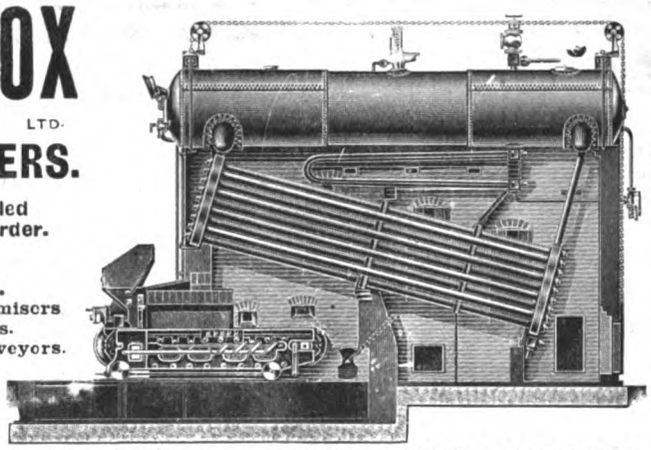

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NOTES.

WE print to-day the second of Mr. John Geo. Leigh's important series of illustrated articles on Electricity in the Navigation of the Panama Canal; and we would take this opportunity of acknowledging the great courtesy extended to the ELECTRICAL ENGINEER by the general newspaper press of this country in regard to these articles, references to which appeared in nearly one hundred daily and weekly journals. In regard to these little courtesies, the ELECTRICAL ENGINEER and its contributors have been especially fortunate. Indeed, it may fairly claim to be perhaps the most widely quoted of any technical journal, upwards of two thousand kindly references having been made to various features in connection with it in the course of the past twelve months. Gratitude has been defined by a cynic as a lively sense of favours to come, but it is not wholly in that sense that we here record our cordial thanks for these many kindnesses; otherwise we might mention in this connection the article in this week's issue on Practical Notes on Induction Motors

ADVANTAGE has been taken by a contemporary of the announcement made by Mr. Fortescue that the compilation of a Subject Index to the national library at the British Museum would be a hindrance rather than a help, to the student to review the whole question of the British Museum Library administration. The points selected for criticism are that the Museum Library has an over rigid constitution, and that its method of appointment of untrained Oxford and Cambridge graduates instead of the inclusion of at least a leavening of librarians trained elsewhere, tends to rigidity. The abandonment of the idea of a subject catalogue is deplored, for it is pointed out that Mr. Fortescue's excellent subject index only goes back to 1880. It is suggested that the methods by which the Museum authorities add to their collection, especially of foreign books, might be very considerably improved, and a strong protest is made against the early closing of the Museum and the still earlier hour after which it is impossible to take out volumes from the bookstores. The engineer is so well equipped in London with reference libraries other than that of the British Museum, that it is to be feared that he will not take that interest in the controversy which for its own sake it deserves. Those who have consulted the Museum Library for professional requirements have not infrequently been disappointed to find that the reference books on the reading room shelves are out of date and that they are unable to get access to pericdicals which may have been published for some months. While it may be stated without fear of contradiction that the Library of the British Museum is the best administered in Europe, it is unsatisfactory and discreditable to us as a nation that the Museum is not up to date in all its different branches. Those who know the energy and courtesy of the Museum authorities are the first to acknowledge with gratitude that the fault does not lie with them as individuals.

THE WHOLE crux of the Museum Library reform is a question of expense, for the continued changing of the books on the reference shelves would require highly skilled work that must inevitably be costly. But when this is taken into account it will be generally admitted that a national collection of books is far too valuable for it to be wise to allow its efficiency to be impaired for want of a little further

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expenditure. The "plant" at the Museum is immensely costly, and the wisest economy would be to see that it is kept running at its full power. A comparatively trifling increase in cost would make it possible to get a vastly more rapid service of books, to render the bookstores and the library available for a far longer period than is the case at present, and to keep it up to date in all branches of knowledge. The preparation of a subject catalogue would be a more costly and a lengthier affair, but without it, it is impossible for any man to know what the Museum contains. And the preparation of a subject catalogue that would aim at giving as complete as possible an account of what England has contributed to the world's literature would be an achievement of which the country might well be proud.

THE PROCEEDINGS in regard to the alleged breach of special rules at the Brookhill Colliery at Pinxton have especial interest for all who are concerned in the use of electricity in mines. There were three special points at issue. The first complaint charged the manager with contravening special rule 21 by installing and using electricity, and placing unenclosed fuses more than two feet from the floor, and not being otherwise suitably protected, in the Brookhill shaft pump-room, on October 12. Two further charges were preferred against the defendants as follows :—Contravening special rule 25 by using electricity with the exposed ends of the cables being unprotected and unfinished, and with contravening special rule 34 by the use of electricity without providing an ammeter to indicate the load put on the machine. The prosecution was at the instance of Mr. W. H. Pickering, Inspector of Mines, but before the actual charges were gone into there was a conference between the Inspector and the counsel engaged in the case, as a result of which the case was withdrawn on payment of the costs; Mr. Pickering, explaining on his subsequent return into court that in taking this course he by no means desired to minimise the importance of the special rules which had been violated. It had been admitted that the rules had been violated, but he had been assured that everything had since been put right and there was no likelihood of further cause for complaint arising as all the electrical apparatus was to be put in first class order at once. He had also, he added, been influenced in his decision by the fact that the rules in question were now under revision and that it was intended to make them still more stringent. For the colliery manager counsel admitted that in the early part of the year certain things were pointed out by the inspector, and an undertaking was given that they should be put in order. There was delay in complying with the requisitions, because the colliery company could not get the delivery of the parts required, which were ordered immediately after the inspector's visit. Delivery was delayed until October 17, but on October 12 the inspector visited the colliery again, and of course found the orders had not been complied with. The management were concerned about the safety of the mine, and what was more important, about the safety of the workmen. Everything was now in order, and they appreciated the attitude of the inspector. Even if the work was not done he would give an undertaking that it should be completed at once. On these proceedings themselves we have no comment to make. It was rendered quite clear that the colliery managers had done their best to remedy the matters at fault and that it was not due to any negligence on their part that what had been found to be wrong had not been set right by the time the inspector paid his second visit. But the moral of the case is very clear. Not only are the special rules to be made more stringent, but those who have the administration of the rules will need to act with greater vigilance if they are to keep pace with the activities of the inspectors. However, forewarned is forearmed, and colliery managers may be counselled to take the warning in time.

WHILE on the subject of Electricity in Mines, we may direct attention to some points in the recent address at Derby which Mr. W. C. Mountain delivered before a gathering of colliery managers convened jointly by the National Association of Colliery Managers, the Midland Counties Institution of Engineers, and the Notts and Derbyshire Education Committees. Mr. Mountain, it will be remembered, was the arbitrator for Durham, Northumberland and the Midland Counties when the negotiations between the Home Office and the Association of Mining Electrical Engineers in regard to the Association's proposed amendments to the rules came to be settled by arbitration; and his views, therefore, are entitled to respectful consideration. Mr. Mountain has arrived at the conclusion that the Home Office was brought to deal with the whole question in a very fair spirit. No great hardship, he said, was, in the end, imposed upon mine owners, nor was any unreasonable expense made imperative, while on the other hand important exemptions had been agreed to in the case of existing installations which might, on inspection, be deemed reasonably safe. Colliery managers as a whole will not, we fear, find themselves unreservedly in agreement with these conclusions, but it may be admitted frankly enough that things are certainly not quite so bad as at one time they threatened to become; and at any rate Mr. Mountain has earned the thanks of the industry for his share—which we believe was no small one—in bringing about a considerable mitigation of the original proposals. Mr. Mountain went on to say that the rules endeavoured to secure a better standard of workmanship, enabled high-tension current to be employed practically anywhere underground so long as adequate precautions were taken, and called for the use of armoured cables almost exclusively, and there is, in short, "very little in them as regards the design of switchgear or apparatus generally which could be objected to by those who are desirous, as all managers are, of providing reasonably safe conditions for the men employed in their mines."

THIS brings us to the debatable point at a single step. What is safety and how is it to be secured? Mr. Mountain confessed frankly enough that an enormous sum might be spent on securing safety without attaining it. "The cost," he said, "of complying with the new rules as originally drafted in the case of eleven collieries in the Midland district, would have been £49,000, notwithstanding that all the existing installations were satisfactory, and that scarcely a single accident had occurred in connection with them." This amount has, of course, been very materially reduced, thanks to the representations made to the Home Office, but it is still a considerable sum, and there is still the risk that in certain cases it may be spent in vain. Mr. Mountain went on to deal with the question of earthing, on which his well-known views differ considerably from those of other Electrical Engineers—though that is not, of course, to say that the other engineers are necessarily right and he wrong. He once more reiterated his opinion that the earthing of ordinary voltages in a colliery is an added danger. His experience is that an earthed system is far more likely to break down than an unearthed one, while there is more risk of a man being killed if he touched a live part. The leakage indicator he regarded as one of the most important things in a colliery. Earthing to the surface of the mine was objected to by many, but it enabled a test through and the use of a leakage protective gear, which they could not work by merely having earthplates underground. But, as he justly says, the whole subject of earthing still offers a wide field for consideration and experiment.

DEALING with some of the points with which they had been in the most serious conflict with the Home Office experts, Mr. Mountain cited the official demand that efficient means should be taken for cutting off all pressure automatically from the part of the system affected, in the event of a fault or leakage of current. It was impossible, he said, satisfactorily to observe such a rule without using a protective gear in some form or other. "The result would be that in the case of a defect, without a moment's notice, the whole of the installation would cease, stopping the machinery and plunging the whole mine in darkness."

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While that class of gear appeals to everyone scientifically, and under certain circumstances is very useful, it is, in his view, far too risky a thing to rely on in a colliery. It is far better to depend on supervision and so maintain a reasonable standard of excellence. "An automatic gear gives a totally false idea of security. The amount of current required to operate a thing of that sort is far in excess of what would be required to kill anybody, and it is not therefore a protection against life or fire." On these arguments the Home Office, not, however, without some reluctance, eventually gave way and the clause was altered. The Home Office also yielded to the force of logic in the case of the rule which called for a month's notice of any intention "to introduce, add to, or re-arrange any apparatus." A month's delay would, of course, be preposterous if they happened to be dealing with water or with any conditions that called for prompt action, and provision was accordingly made for anything to be shifted in a hurry. There were other points, too, on which the Home Office proved open to reason, and at any rate it is clear that colliery owners will not be under any immediate necessity to scrap their plant. Provided "reasonable safety" is assured in existing installations, they are not to come under the rules for another eight years; but it is up to the colliery owners and managers to see that this "reasonable safety" is assured to the satisfaction of the inspectors; and there are indications that this satisfaction will not be too easily assured.

FROM the official report which appears in another column it will be seen that between sixty and seventy engineers were present at the inaugural meeting of the newly formed Association of Consulting Engineers, and that it has been decided as a cardinal principle of the new organization that corporate membership of the Institution of Civil Engineers shall be a condition precedent to membership of the Association of Consulting Engineers. Mr. James Swinburne, who presided, said the Committee wished to be logical in carrying out their idea of starting on the narrowest lines and felt that they should confine the Association, initially, at any rate, to those regularly in practice as consulting engineers, and having their own separate office and staff. But the Association, he added, did "not aim at stopping consulting engineers who might not join them from doing consulting work," nor did they wish to claim a monopoly, but they felt that engineers falling within the class outlined, were entitled to band themselves together and become recognised as "*the* body of consulting engineers." But are not these restrictions likely to defeat the very purpose the new organization has in view? A corporate member of the Civils has practically all the status he needs without joining a new body confined within such narrow limits as those indicated by Mr. Swinburne. Mr. Swinburne says the Committee has no wish to claim a monopoly, but surely that is the very thing they are doing if, within these narrow limits, they desire to be recognised as "*the* body of consulting engineers." As to not preventing non-members of the new Association from engaging in connecting work, all that need be said is that the Association could not prevent them, even if it would, and we fear the mere disclaimer will cause a good deal of resentment. We are left in the dark as to the discussion which followed the Chairman's address, but from the reticence observed in the official report, it may fairly be assumed that the proposals were not received with complete unanimity. We had looked forward to this Association as one likely to be very helpful to the engineering profession, but on the whole we must confess that the inaugural proceedings leave us with a sense of disappointment. We should like to hear the views of our readers with regard to the points raised.

WE have scrupulously refrained from any reference in these columns to the slanderous statements which have been in circulation with regard to Madame Curie, because we held that they carried with them their own reputation. We are very glad, however, to be able to put on record Mrs. Hertha Ayrton's vigorous protest against the unwarranted deduction drawn in certain quarters with regard to the cry of "Shame" which at a recent suffrage debate greeted the mention of Madame Curie's name. The cries were directed, says Mrs. Ayrton, not against Madame Curie, but against the women who dared to repeat a lie that has long been disproved. "If any of your readers are curious," says Mrs, Ayrton, "they will find in 'Le Temps' for November 5, 1911, a complete disproof of the accusation made against Madame Curie—a disproof that was the result of a careful investigation made by that journal and of evidence given by some of the most distinguished men of science in France. The scientific woman," Mrs. Ayrton adds, "is peculiarly open to misunderstanding and misrepresentation from the very nature of her work. She must frequently conduct experiments alone in a room with only one other person, who has usually to be a man, because at present so few women are fitted for the post. But to the investigator the collaborator is neither man nor woman, but simply a mind, engaged with her mind, in tracking down an idea—in solving a problem. She cannot be bothered to consider the sex of her colleague, nor, indeed, would it ever enter into her head to do so. That nasty people should import notions of sex into this purest and most abstract of all relations between men and women might be a tragedy if it were not such a farce. A great woman like Madame Curie will always be a mark for the envy and spite of small minds, but to one who has seen her in her own home, the devoted and adoring mother of her two daughters, no such accurate evidence of her innocence as was forthcoming is necessary to prove that she is as pure and noble as she is great."

A CABLE from the New York correspondent of the "Times" announces that the difficulties in regard to the construction of the new and colossal system of underground electric traction have at last been smoothed away and the work is to be done, after all, by the Interborough Rapid Transit Company. It is stated that the scheme will provide for the preferential payment of 8¾ per cent. on the Interborough $125,000,000 capital invested, consisting of about $48,000,000 in the present subway system and of $77,000,000 in the new subways. The Interborough Company waived 8¾ per cent. of the guarantee by the city for the preferential payment of the same amount, but the latter is tantamount to a guarantee, since it will be given to the Interborough Company before any other deductions are made. The syndicate headed by Morgans will handle $150,000,000, underwriting the necessary amount for constructing and equipping the new subways and extending the elevated lines, and Mr. Morgan, jun., or Mr. H. P. Davison, or both, of Morgan & Company, and possibly the representatives of the First National and National City Banks, will be elected to the Interborough directorate.

THE MERCURY LAMP.

It is well known that the mercury lamp (often called the Cooper Hewitt) has the disadvantage of emitting light of a greenish blue colour. Dr. Steinmetz proposes to add to the mercury substances which cause emission of red the complementary colour. Sodium, potassium, lithium, rubidium and thallium, all have this effect, but cause rapid corrosion of the glass tubes and form a black opaque coating inside them. This difficulty disappears if iodides or other haloid salts of the above metals are substituted for the metals themselves. An equally effectual method is to coat the inside of the tube with a silicate of one of the metals. Metasilicate of lithium serves the purpose. To lessen the voltage necessary to start the arc in a mercury lamp, Dr. Steinmetz fills the vacant part of the lamp with hydrogen at extremely low pressure.

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Electricity and the Navigation of the Panama Canal.—II.

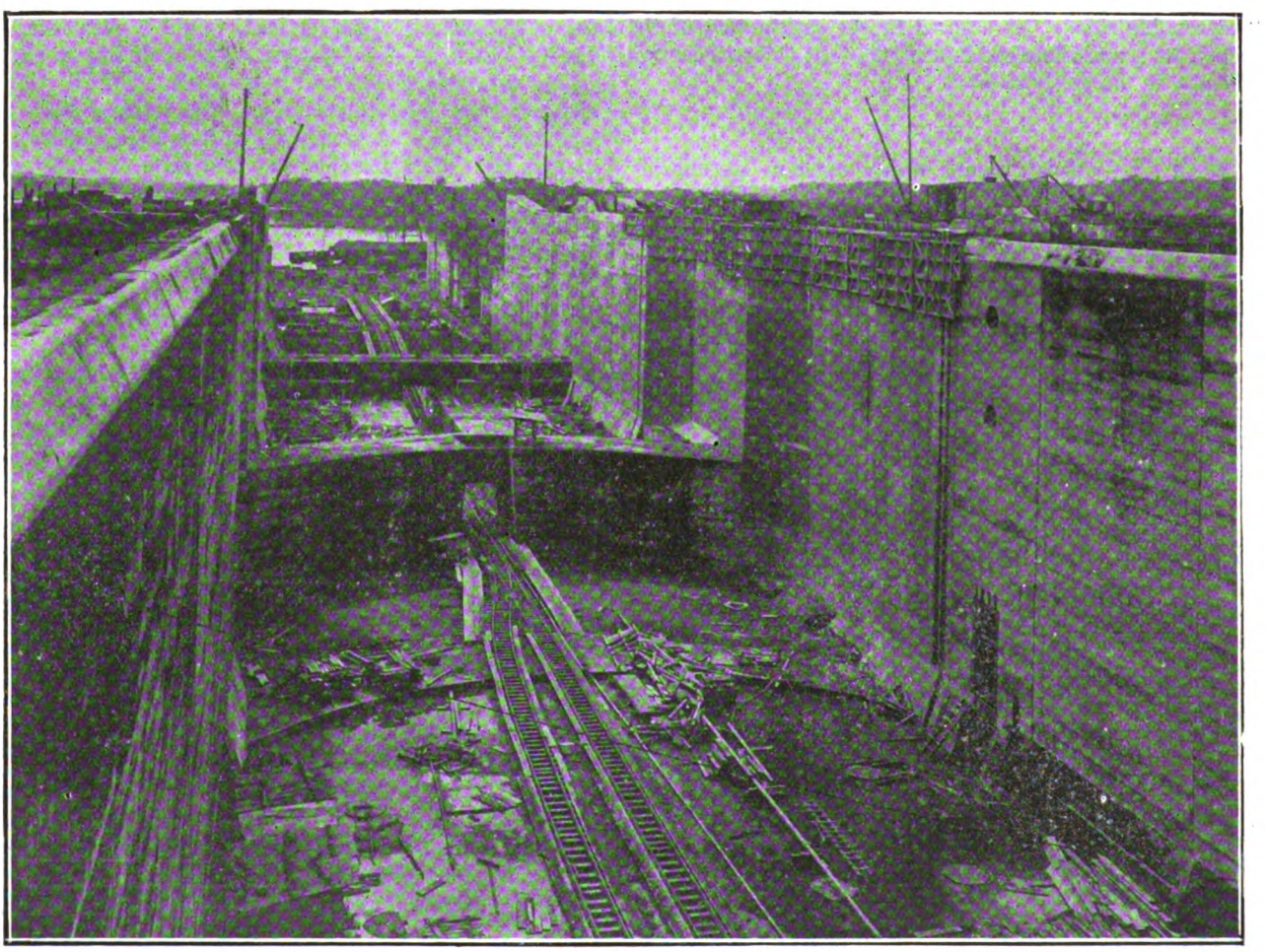
By John Geo. Leigh.

As the result of between three and four years' work, there has just been completed, at Buffalo, New York State, a lock of such dimensions that it will accommodate the largest of the cargo-carrying vessels navigating the Great Lakes. It is 600 ft. long, 70 ft. wide, and 24 ft. deep; has five pairs of steel gates; is operated by power derived from the adjacent Niagara Falls, and has cost in construction about £258,000. I find it described, on the strength of these figures—presumably the writer had forgotten temporarily that such an enterprise as the completion of the Panama Canal was in progress—as a "colossal undertaking," and the "largest inland ship lock in the world."

These adjectival comments are of opportune value and interest, for they constitute, as it were, a standard of comparison, and will enable me to dispense, in the references which I am about to make to the locks of the Panama Canal, with the use of superlatives. It is quite possible that with many of the details to be mentioned readers are already in greater or less degree familiar; but their repetition in this place may be excused, and even, perhaps, be held advantageous, as helpful to a clear appreciation of the purposes of the operating machinery of the Canal and its electrical equipment.

There will be in the future great maritime highway three sets of locks, of identical design and dimensions, all constructed in duplicate, *i.e.*, with centre walls and twin parallel chambers, providing for uninterrupted navigation in the event of any lock on either side being temporarily out of service, or for simultaneous use by northbound and southbound traffic. In the Act of Congress authorising the purchase and completion of the Canal, provision was made that the locks should be of such size "as will afford convenient passage for ships of the greatest tonnage and draught now in use, and such as may be reasonably anticipated." Having regard to this stipulation, the present Commission originally arranged that the lock chambers should be 1,000 ft. long, 100 ft. wide, and 41 ft. deep; but, early in 1908, the width was increased by 10 ft., in deference to an expression of opinion by the General Board of the Navy that 100 ft. might prove insufficient for "probable ships of future construction." Very few ships, however, exceeding 600 ft. in length, are expected to use the Canal, and for this reason and with a view to economy of time and water, intermediate gates, capable of dividing the locks into chambers of more moderate lengths, are being installed.

The longest flight of twin locks, three in number, is at Gatun, and extends, with approach walls, a distance of nearly 1½ miles. It has a combined lift of 85 ft., thereby raising or lowering vessels from the levels of the Atlantic and Gatun Lake. At Pedro Miguel, on the Pacific side of the Culebra Cut, 40 miles distant from the Atlantic entrance to the Canal, southbound vessels will enter a single lock and be lowered 30⅓ ft. to a small lake, 54⅔ ft. above the mean of the 20 ft. tidal range at the Pacific terminal. This lake ends at Miraflores, where, by means of two locks in series, a drop will be made to the channel, 500 ft. wide at the bottom, 45 ft. deep, and 8½ miles in length, leading to deep water in Panama Bay. It is estimated that in the construction of these locks there will be used 4,200,000 cu. yds. (or tons) of concrete. Of this aggregate there had been placed, at the close of 1911, nearly 75 per cent., viz., about 1,750,000 cu. yds., out of 2,000,000 cu. yds., at Gatun; 785,000 cu. yds., out of 837,140 cu. yds., at Pedro Miguel, and about 580,000 cu. yds., out of approximately 1,362,000 cu. yds., at Miraflores.



UPPER LOCK CHAMBER AT GATUN, SHOWING GATE SILLS.

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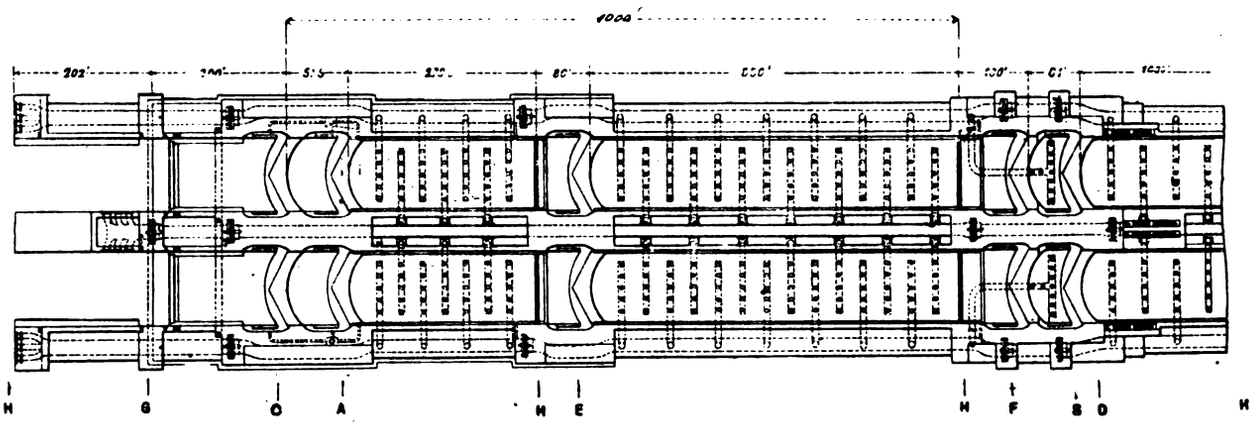


GENERAL PLAN OF LOCKS, SHOWING GATES, PROTECTIVE DEVICES, AND CULVERT SYSTEM.

A—Upper Gates, 79 ft. high; B—Lower Gates, 79 ft. high; C—Upper Guard Gates, 54 ft. 8 in. high; D—Lower Gua d Gates, 7ɔ ft. high; E—Intermediate Gates, 79 ft. high; F—Safety Gates, 79 ft. high; G—Emergency Dams; H—Fender Chains.

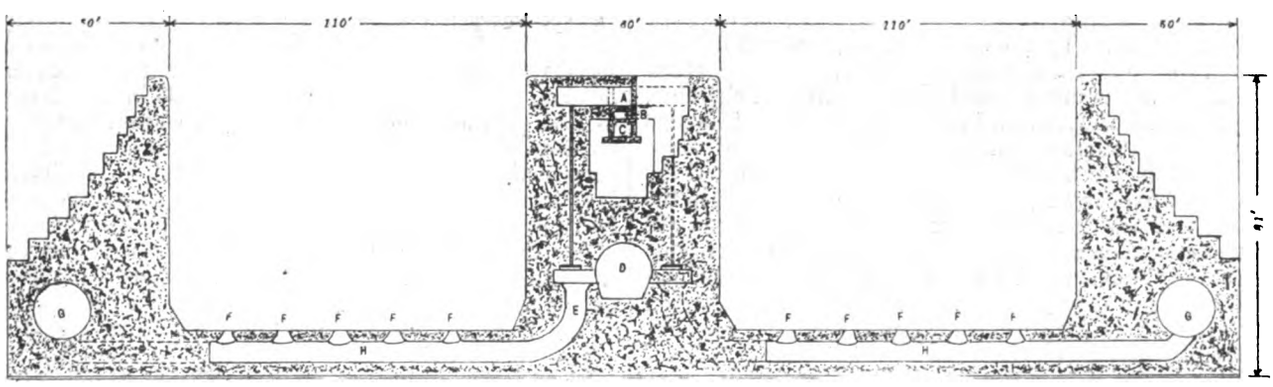
So extensive is the system of light, power, signal and control circuits for operating the locks that no attempt can be made within the limits of the present article to more than outline its features. These include a continuous tunnel running the full length of each lock wall, with a continuous conduit space beneath its floor, connections between the several lock walls being obtained through vertical cable shafts and tunnels under the lock chambers. All cable manholes and junction boxes, as well as all stationary machines or power centres will be on the level of the tunnel floor, and accessible from it. The basic idea underlying the control and interlocking system is that all the gates and valves and other apparatus shall be operated from a single point—a tower situated on the centre lock wall at the lower end of the upper lock in each flight. The operating-room will be equipped with indicators showing the position of each of the machines and the water levels of the various pools under its control, the system being so interlocked that all operations must take place in the proper sequence.

The aggregate weight of the 42 lock gates, so far only as movable parts are concerned, exceeds 57,000 tons. Each gate has two leaves—built up of steel sheathing riveted on girders—each 65 ft. long, 7 ft. thick, from 47 ft. to 82 ft. high, and weighing from 275 tons to 500 tons. At all the locks, at all important points, the gates are double; and additional precautions—to which later reference will be made in connection with their operating machinery—combine to reduce to a minimum the possibility of damage to shipping or the structures themselves. To fill and empty the lock chambers, culverts, having a sectional area of 254 sq. ft. —greater than that of most tube railways—extend the entire length of the middle and side walls; and from these smaller culverts pass under the lock floor, and, by means of holes in the latter, communicate with the lock chamber. Control is effected at various points in the longitudinal culverts and at the junctions between the main and lateral culverts by no fewer than 240 rising stem-gate valves, half of the Stoney gate and half of the cylindrical type, each requiring its individual operating machine and electrical equipment.

As some of these valves will operate under a head of about 60 ft., and must remain tight under a head of 80 ft., great strength in the different parts is essential. Thus it happens that the weight of the moving parts only of each valve of the Stoney gate type is 22,500 lb. in air, as compared with the more moderate corresponding weight of 7,600 lb. in air in the case of the cylindrical valves, which will be subjected to less pressure and will operate ordinarily under a comparatively low head. The mechanism required for the operation of the valves of the first-mentioned type will be driven, through a friction cut-off coupling, by a three-phase, 220-volt, 25-cycle induction motor. This will be provided with a solenoid brake in order that the revolving parts may be brought to rest immediately after interruption of the line current. The electrical equipment includes also a limit switch to cut off the current at the proper point in the travel of the crosshead to which the upper end of the valve stem is carried. In the case of the cylindrical valves, the upper end of the stem terminates in a tubular extension carrying a stationary nut, which engages a non-rising revolving screw, turned through suitable gearing by a motor. A solenoid brake brings the machinery to rest when the current is cut off, and a limit switch stops the travel of the valve in either direction at the proper moment.

In order to avoid the creation of disturbing currents in the locks or approaches, which might be caused by the use of too many valves or by the sudden opening of the latter, an average of 15 min. will be allowed for filling or unwatering a lock. On this basis, the time required to pass a vessel through all the locks is estimated at three hours—about half that period for the triple flight at Gatun, and the other half for the two locks on the Pacific side. The passage of a vessel through the entire 50 miles separating the two terminals of the Canal will, it is believed, be effected in from 10 to 12 hours, according to the size of the ship and its speed when steaming through the wide terminal and lake channels.

To turn each of the ponderous gate leaves of which mention has been made, separate mechanism will be required. The machine invented for the purpose is the work of Mr. Edward Schildhauer, the Canal Commission's senior electrical and mechanical engineer, and the designer of the electric towing locomotive described in an earlier article. Its essential feature is a cast-steel wheel, 19 ft. 2 in. in diameter, and weighing about 35,000 lb., which is mounted in a horizontal position on the lock wall and connected with the



CROSS SECTION OF LOCK WALLS, AND DUPLICATE LOCK CHAMBER.

A—Passageway for operators; B—Gallery for Electric Cables; C—Drainage gallery; D—Centre wall culvert; E—These culverts run under the lock floors alternately with those from the side walls; F—Wells opening from lateral culverts into lock chamber; G—Side wall culverts; H—Lateral culverts.

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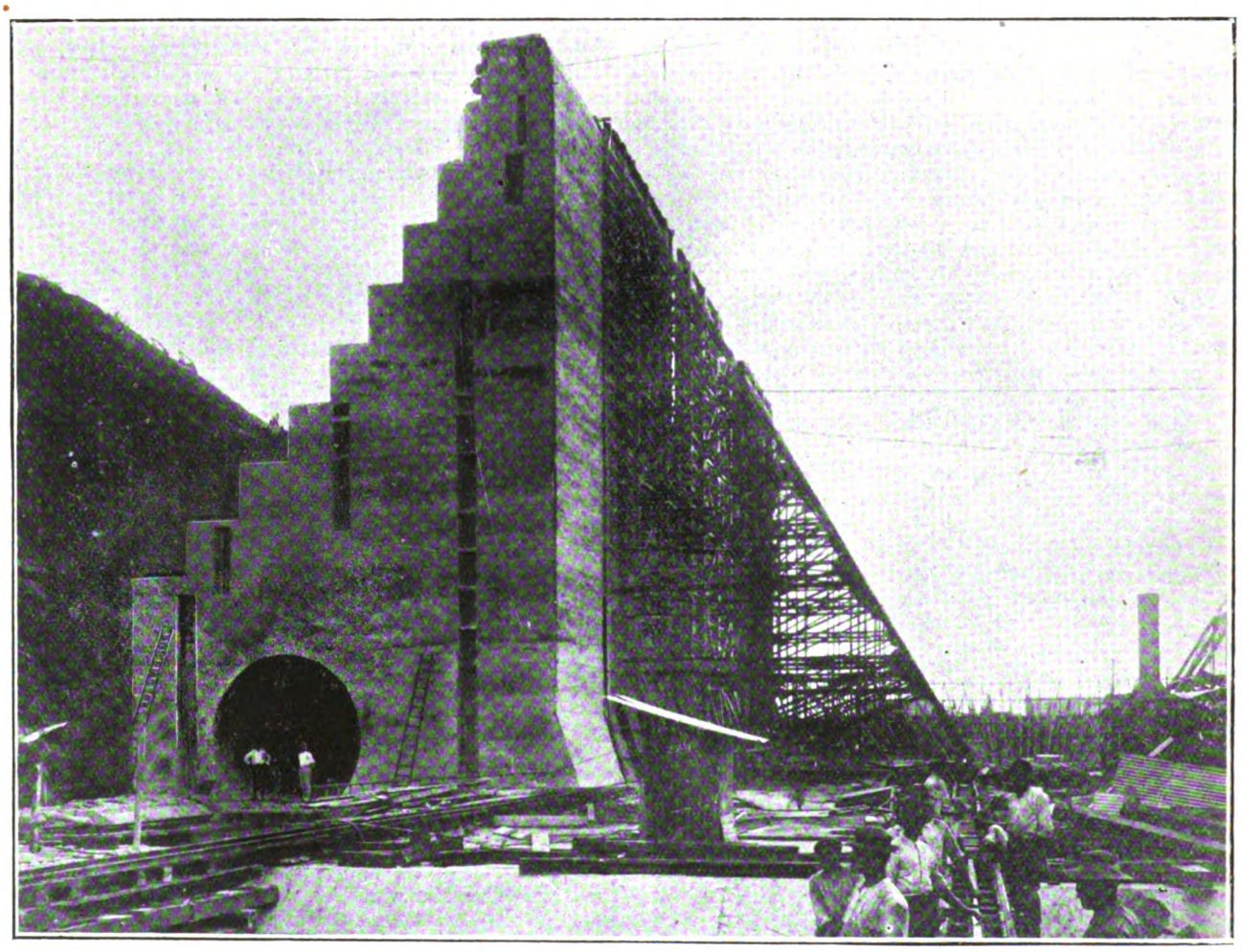
top of its associated gate leaf by a built-up strut, or rod, provided with a spring shock absorber. The wheel is driven by a single pinion on a vertical shaft, the latter being actuated by a bevel gear and pinion. This last is fast on a horizontal shaft, which passes through a bulkhead separating the motor and wheel chambers, and carries a gear with spring centre driven by a pinion on the back shaft of the motor. By means of this machinery, a gate leaf can be opened or closed in, it is estimated, 2 min.

Before, however, the operation can be said to be complete, a second machine, also motor-driven, has to be called into service. This is required to force a pair of leaves to perfect mitre and lock them in that position. For this purpose there is bolted to the outer end of the top girder of each gate leaf a box-shaped casting, one carrying a pair of movable jaws and the mechanism by which they are operated, and the other a pin on which the jaws are securely fastened when the gate is tightly closed. To bring about this result, one of the essential parts of the mechanism, a screw, is turned by a bevel gear in mesh with a bevel pinion on the motor driving shaft. The motor is provided with a solenoid brake, by which the machine is brought quickly to rest when the current is shut off by the limit switch.

Reference to an accompanying illustration, showing the positions occupied by the several lock gates, will indicate that in the approach to each upper lock, at a point about 200 ft. above the upper guard gate of each twin chamber, will be placed what is called an emergency dam. The purpose of this structure will be to check the flow of water from the lake level, in the event of damage to any of the gates, or should any repair or other work be required in the locks, necessitating their closure. Each of these dams will be constructed on a steel truss bridge of the cantilever type, pivoted to the side wall on which it will ordinarily rest, and from which it may be swung across the channel, when required, with its long arm resting on the middle wall. For its complete operation, there will be required three types of machine. The first will consist of two reversible, open motors—each having a capacity of 112 h.p.—for turning the bridge, a limit switch preventing movement beyond an arc of 90°, and a motor for driving the steel wedges provided to hold the bridge firmly in place across the lock approach or when at rest on the side wall. Hinged to the bridge in such a manner that they may be lowered through an angle of 90° is a series of six wicket girders, the lower ends of which rest—when the bridge has been swung across the channel and the dam is being brought into use—in iron pockets embedded in the masonry floor. To lower each of these girders there will be employed a second type of machine, consisting of a hoisting drum, driven by a motor, equipped with a limit switch. The girders in place, six panels, or gates, moving in them on roller bearings, will be allowed to fall, until they span the width of the canal, damming the water to a height of 10 ft. Other series of six panels will then be lowered in succession until a dam is constructed from the bottom upwards, completely closing the channel. In each of the emergency dams to be installed at Gatun and Pedro Miguel there will be five tiers of panels, or 30 of the latter in all. At Miraflores, however, owing to the less depth of water in the locks, the dams will be but four panels high. The gates, or panels, will invariably roll into place by gravity. When, however, a dam is to be opened, they will require to be hoisted out of the water by mechanical means. There will, consequently, be needed for the six emergency dams 12 motors to operate the bridge-turning machinery, with six limit switches and six motors for driving the wedges; 36 wicket girder lowering and hoisting machines, with 36 motors and 36 limit switches; and 36 gate hoisting machines, with an equal number of motors. The aggregate weight of metal to be used in the construction of these dams and their electrical equipment is estimated at 12,000 tons. Even more suggestive is the fact that—though in no way essential to the safe navigation of the Canal, and probably destined to be used but very occasionally—the six dams will cost over £460,000, or nearly double the total expenditure involved in the construction of the "colossal undertaking" referred to in my introductory paragraph.

The primary purpose of the fender chains, 24 in number, which are to be stretched across various points of the lock channels, is to prevent the gates nearest to them from being rammed by a ship approaching under its own power, or



A SEMI-COMPLETED SIDE WALL AND THE STEEL LATTICE USED IN CONCRETE LAYING.

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which may have eluded its escort of towing locomotives. A fender chain, therefore, will always be in service except when it is desired to pass a ship through the lock and there is no possibility of danger. It will then be lowered into a groove extending across the lock floor by mechanism mounted in pits in the opposing lock walls. As at present arranged, the machinery to be employed for this purpose will be largely hydraulic, the use of electric power being confined to operating the centrifugal pumps which will force water into the cylinders and the drainage pumps by which the pits will be unwatered. The centrifugal pumps will be started automatically by a quick-acting electric switch, actuated by a system of rods and levers, changes of flow being produced by varying the position of the operating valve by means of a solenoid operated by remote control. It should be noted that, even in this connection, the adoption of hydraulically-operated machinery is regarded with scant favour by the Canal authorities. Pending a test of its efficacy in producing, under actual working conditions, adequate resistance to the paying out of a chain, but one sample fender chain machine has at present been ordered, it being understood, should it prove unsatisfactory, that frictional resistances, with winding machines driven by electric motors, will be installed as an alternative.

That the Canal authorities have shown themselves eminently friendly to the claims of electrical energy cannot be for one moment gainsaid. Their predilections, however, in this direction have never blinded them to the paramount essentials that all electrical equipment to be installed in the Canal must be of the highest quality and peculiarly suited to the service to which it is destined to be applied. The specifications, consequently, have always been exceptionally precise, requirements as regards quality being sometimes expressed with a directness possibly unpleasant to many would-be contractors. The Commission, moreover, in regard to invitations issued for the supply of electrical plant, have seldom failed to exercise their legal right to invoke the President's authority to avail themselves of the foreign market, in the event of domestic tenders, in the first instance, proving unsatisfactory. A conspicuous instance of this readiness was presented in the case of the motors and limit switches required for the operation of the lock valve machinery ; and even now, it should be noted—though two years have elapsed since the opening of the first tenders—no order other than for sample plant has been given for this equipment.

For the purpose of testing the eight motors supplied by three American manufacturers, a special shed has been erected near the locks at Gatun, and here every effort will be made to determine what type will best withstand the deteriorating effects of the Isthmian climate. The tests include (1) The measuring of insulation resistance and the application of a 1,500 volt high potential test for 1 min. ; (2) the measuring of insulation resistance just prior to turning on steam and at intervals of 6 hours thereafter ; (3) the removal of hand-hole covers to admit to the room saturated steam so that the air is at a temperature of 50° C. ; and (4) subjection to a high potential test of 1,000 volts 10 sec. every 24 hours. If the data obtained after a week's continuance of these tests fail to show any definite results, the trials will be resumed in a temperature of 75° C. ; and, in addition, the motors will be immersed in water at normal air temperature, the insulation resistance being measured just before and after immersion. At intervals of 6 hours for 2 days just prior to removal from the water a high potential test of 500 volts will be applied for 10 sec. Should these additional tests not show conclusive results, internal heat will be applied by running the motors at regular or higher pressure, with the objects of rendering the insulation more porous and of indicating the rapidity with which the moisture in the insulation will be driven off.

For lighting the Canal, there are being placed in position 34 range towers, constructed of reinforced concrete varying in height from base to focal plane from 29 ft. to 74½ ft. ; 57 beacons, of similar construction, 15 ft. high from base to focal plane ; 57 gas buoys, and 85 spar and nun buoys. As at present arranged, electricity will be used for all the lights, other than buoys, in the Atlantic, Pacific, Culebra and Miraflores sections, and acetylene gas for the buoys in all sections and the beacons in Gatun Lake. The same form of energy will, it is almost needless to add, play a very conspicuous part in the operation of the monster docks now in course of construction near the ocean terminals of the Canal—at Cristobal, on the Atlantic side, and at Balboa (formerly La Boca), in the channel leading to Panama Bay.

PERSONAL.

At a smoking concert held at the Rawson Hotel, Bradford, on Friday last, a presentation was made on behalf of the staff and employees of the Bradford Corporation Electricity Department, to Mr. H. S. Ellis, on the occasion of his vacating the post of deputy city electrical engineer and manager in Bradford, to take up the position of borough electrical engineer at South Shields. In making the presentation, which consisted of a solid silver cigarette-box, cigarette-case, and a match-box, Mr. T. Roles, city electrical engineer, paid a tribute to the able manner in which Mr. Ellis had carried out his duties in Bradford, and wished him every success in his new sphere of labours. Alderman G. H. Robinson, chairman of the electricity committee, expressed on behalf of the committee their appreciation of Mr. Ellis's services. The following members of the staff representing the various departments also testified to the good feeling which had always existed between them and Mr. Ellis, and to his never failing courtesy towards them on all occasions : Mr. J. H. Schnauber, deputy engineer ; Mr. J. Fairbairn, deputy works superintendent ; Mr. G. R. Brown, generating engineer ; Mr. J. B. Albrew and Mr. C. A. Gillin, mains department ; and Mr. C. B. Holdsworth, secretary. Mr. Roles made apologies for the absence of Councillor Jas. Hustler, deputy chairman of the committee, who had a prior engagement, also for Mr. Wm. Jones, works superintendent, who is away recuperating after a long illness, and for Mr. C. E. Allsopp, consumers superintendent.

The opportunity was also taken by Mr. Badge, electrical engineer to the Bradford Dyers' Association Limited, to hand Mr. Ellis, on behalf of the staff of his department, a pair of silver vases, as a mark of the esteem in which Mr. Ellis was held by them. Mr. Ellis, in acknowledging the presents, expressed his appreciation of the kindness and assistance he had received at the hands of all he had come into contact with during his five years' association with the electricity department of the Bradford Corporation.

A capital programme of humorous and musical items was sustained by members of the Corporation staff and the Bradford Dyers' Association's staff. Needless to say the evening was a thoroughly enjoyable one.

The Office Staff of the Foster Engineering Company, Wimbledon, assisted by members of the Engineering Works, and other departments, gave a very successful concert to which members of the Metal Filament Lamp Works were invited. Members of the staff and guests were present to the number of upwards of 150. The directors Mr. M. V. Ely (who occupied the chair), Mr. Grote, Mr. E. Dobson and Mr. Lazenby were present ; also Mrs. M. V. Ely, Mrs. Grote, and friends, Mr. S. H. Cowen(secretary), Mr. Hill (export and publicity departments), Mr. Delfosse (works superintendent), Mr. Gwyn (superintendent of the lamp works), and other heads of departments, including Mr. Scott (head of the laboratory), and friends of the members of the staff and travelling representatives. The entertainment was eminently successful, and at the close Mr. M. V. Ely referred to the great and rapid growth of the company's business, and the extension of the works which had already been found necessary, although the company had only built their present works a few months since.

At a meeting of the Electricity committee of Dundee Town Council it was unanimously agreed to recommend that the salary of Mr. Harry Richardson, the engineer, should be increased by £100, making it £700 per annum. Mr. Richardson received the appointment in 1903 at a salary of £400 per annum.

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The Institution of Electrical Engineers.

RESIDENCE TARIFFS.

Resumed Discussion on Mr. A. Hugh Seabrook's Paper.

The discussion on Mr. A. H. Seabrook's paper dealing with Residence Tariffs was resumed at the meeting of the Institution of Electrical Engineers last Thursday.

Mr. J. S. HIGHFIELD strongly advocated more uniform tariffs for electricity supply. Much had been said on the point that the charge to the customer should bear some relation to the cost of giving the supply. He had examined some figures relative to the financial arrangements of gas, electricity and water undertakings. He took six of the largest undertakings and had reduced the figures so as to give a constant of 8% on the aggregate capital. Taking £100 as the capital employed in all three instances, he found that the gross revenue for the gas concerns was £52, for the electricity £13 5s., and for the water £10. The costs were £24 for gas, £5 5s. for electricity, and £2 for water, while the ratio of cost to revenue worked out at 75 in respect of gas, 40 in the case of electricity, and 21 in the case of water. From these figures it appeared to be quite proper to charge for gas per 1,000 ft., as the working charge was by far the most important item in the total charge. As regards water, the working charge was only a very small proportion, and, therefore, it was quite sound to charge on the basis of rateable value. But electricity came between these two, and, in his opinion, the figures showed considerable justification for Mr. Seabrook's telephone system of a fixed charge per year or quarter depending on the demand and a low rate per unit according to the number of units taken. He was inclined to the opinion that ultimately the load factor of electricity works would improve to such an extent that the finance would approximate to that of a gas undertaking, owing to the extended use of electric cookers and heaters, and the final charge might be a flat one of so much per unit. He maintained that 2d. per unit was a perfectly proper rate per unit for power for small purposes. He, however, failed to see any reason for reducing the price to 1d. per unit in respect of cookers. Slot meters, according to his experience in the large towns covered by Edmundson's Electricity Corporation, had been a failure, and the same remark applied to the fixed charge per lamp system. The speaker mentioned that he had successfully substituted a weekly contract system, whereby the consumer paid 6d. or 1s. per week, entitling him to a limited number of units, and 1d. or 1½d. per unit for extra units taken.

Mr. L. E. BUCKELL reminded Mr. Seabrook that the tariff for a new undertaking must differ from that arranged for filling up the mains of an established concern. He suggested that another form of tariff meriting considera ion was the division of the consumers into classes, with different tariffs for each section. Taking the demand of each class for the year and working out the load factor, a tariff might be arranged which would not be any more arbitrary than one based on the principle of the telephone system. The importance of load factor in determining the price was often overlooked. Mr. Buckell said he had adopted the Norwich system, because, unlike the telephone system, it gave an inducement to the customer to increase his load.

Mr. E. W. COWAN approved of the telephone system, for the reason that it embodied the principles of classification. He appreciated that a drawback to the telephone system was that it classified by one rigid classification only. He believed that the author of the paper was going along the right road.

Mr. A. J. CRIDGE disputed the contention that a limiter cost nearly as much as a meter. That was not so, unless it was an electrolytic meter. He did not agree with those engineers who were endeavouring to abolish meters. In any system without meters there was great waste. The Norwich system was inflexible, but he did not think that was a disadvantage. The telephone system was based upon someone's idea of the load connected, and, in so far as it enabled the Chief Engineer to do what he wished with the method of charging, he regarded it as a good system.

Mr. W. E. BURNAND held that it was essential to arrange a tariff that would encourage other uses of electricity. The efficiency of metal filament lamps was likely to be still further increased, with the consequence that the lighting load must in the end take second place. He favoured a system with, firstly, a fixed charge corresponding to the actual cost of the various classes of service; secondly, a low rate per unit; and, thirdly, an additional higher rate for electricity used at the special high peak when the load approached the plant capacity. That would involve a two-rate meter, and he felt certain it was not beyond the ingenuity of the electrical engineer to devise it.

Mr. BARKER claimed that the contract demand system was the ideal system at present. This was in reality a maximum demand system without an indicator. He thought there might be a system of graduated fuses, so that directly the contract demand was exceeded the first fuse went and the installation was switched on to the second and so on. The customer's account could be reckoned on the number of fuses which had blown.

Replying to the discussion, Mr. SEABROOK looked forward to the time when co-ordination of electricity supply in London would help materially towards uniformity of charging. The discussion, he thought, had elicited, firstly, that it might be taken that a differential rate was to be preferred to a flat one; secondly, that little, if any, constructive criticism was forthcoming; and, thirdly, that if the telephone system was all wrong no better system had been submitted. Perhaps the most important point, however, was the suggestion in favour of the Institution selecting a committee to deal with the whole question. He thought that at present it could not but be admitted that the position was somewhat chaotic and most unsatisfactory, but the appointment of a committee to deal with the subject might ultimately lead to a standard method of building residence tariffs being established.

IRON IN COPPER CONDUCTORS.

The further development of several types of galvanometer is only possible, says a writer in the "Electrochemische Zeitschrift," if absolutely magnetic copper wire—wire that is free from iron is available. Such wire is practically unobtainable. The fact is the more remarkable as Tyndall was able to get diamagnetic copper wire in 1867. It is generally supposed that electrolytically deposited copper is free from iron and that the iron is introduced into the wire in wire-making processes. This can hardly be the case, for the writer tried a year ago to substitute silver, a still more diamagnetic metal, for copper in making galvanometers. The silver wire obtained was at first distinctly magnetic, but after scraping was diamagnetic. Hence the magnetism was due to iron left on the surface when the wire was drawn through iron draw plates. This explanation never accounts for the presence of iron in copper wires. Tests of a mass of electrolytic copper, weighing 3¾ lb., showed that it was already magnetic. The iron might have got into it during the electrolysis, or in the remelting. Now for the remedy. The writer has found that even when the electrolyte contains notable quantities of iron diamagnetic copper can be got if the bath is kept strongly acid and continuously and energetically stirred, but the current density must at the same time be kept low. The preparation of iron-free copper for making electrical apparatus is a matter of urgent necessity on both scientific and technical grounds, even if it does increase the cost of such instruments. So far as is at present known, the only way of getting iron-free copper is to prepare it electrolytically by the method above described.

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The Father of Electrical Science.

William Gilbert of Colchester.

Notes, biographical and otherwise, of the early philosophers, writers, and navigators mentioned by him in "De Magnete." Some curious observations and opinions especially concerning the loadstone and several objects magnetical.

(*Continued from page* 59.)

MENELAUS (called also Milleus by Appian and by Mersenne) was a celebrated Alexandrian living end of first century A.D., who in his brilliant treatment especially of spherical geometry went considerably beyond all his predecessors. Menelaus is mentioned by Gilbert (Bk. VI, Ch. 8, 9) together with Hipparchus, Ptolemy and Machometes Aractensis who, says he, "have all held in their writings that the fixed stars and the whole firmament have a forward movement, for they contemplated the heavens and not the earth and knew nothing of magnetic inclination."

MERULA, GAUDENTIUS, Italian savant, living early in the sixteenth century, is the author of *Memorabilium*, wherein, according to Gilbert, Merula advises that on a loadstone be graven the image of a bear, when the moon looks to the north, so that, being suspended by an iron thread, it may win the virtue of the celestial bear.

MONTAGNANA, BARTHOLOMEO, who is alluded to at the end of Ch. 15, Bk. I of *De Magnete*, which latter treats of the medicinal power of iron, was the head of a very well known family of Italian physicians. He was born about 1400 A.D., practiced medicine at Bologna and Padua, and wrote several valuable works, the two best known being *Consilia Medica*, 1436, and *Balnis Patav*, 1556.

MONTANUS, ARIAS—BENEDITUS—(1527–1598), eminent Spanish Catholic divine and orientalist, member of the Council of Trent, is most celebrated for his Polyglott Bible—*Biblia Regia* or *Biblia Plantiniana*, although he is the author of many other works published between 1569 and 1593. Upon completing the last of the eight folio volumes of the *Biblia*, he declined a bishopric offered him by King Philip II, at whose request he had undertaken the work and who later rewarded him with a liberal pension and other emoluments.

MONTANUS—DA MONTE—JOANNES BAPTISTA (1488–1551) already mentioned in connection with Amatus Lusitanus, was a professor of medicine at the Padua University and one of the most celebrated physicians of his day. He is the author of many truly valuable works, including *Metaphrasis Summaria* and *Razis al AlmansorExpositio*, to which Gilbert makes references in his first chapter.

MYREPSUS, NICOLAUS, Greek physician living in the thirteenth century, is the author more particularly of a medical treatise (divided into forty-eight sections containing as many as 2,656 formulae) which was translated by Leonard Fuchs under title *Nic. Myr. Alex. Medicamentorum Opus* and frequently reprinted. Another translation was made by Nicolas de Reggie who, like Matthaeus Silvaticus, was a physican at Salerno and who called it *Nic. Alex. liber de compositione medicamentorum*. The last named work has by some been confounded with the *Antidotarium* of Nicolas Praepositas. At the end of chapter 14, Bk. I, treating of the medicinal virtue of the loadstone, Gilbert speaks of Myrepsius whose "divine plaster" (emplastrum divinum) contrary to the opinions of many, was made of powdered loadstone mixed with litharge, oil, wax and different spices.

NICANDER OF COLOPHON, whom Gilbert twice mentions in Bk. I, Ch. 2, treating of the nature of the loadstone or magnet and of the myth of magnetic mountains, was a Greek poet and physician who lived in the second century B.C., and whose numerous works are cited frequently by Pliny and other ancient writers.

NICETAS—HICETAS—OF SYRACUSE, a Pythagorician of the forth century B.C., native of Chonae in Phrygia (the old Colossae of St. Paul), alluded to by Gilbert in conjunction with Heraclides of Pontus and Ecphantus, and with Aristarchus of Samos, was, doubtless, the first, according to Diog.Laert. (VIII, 85) to teach the earth's rotation.

Humboldt remarks (Cosmos, 1860, II, 109) that Hicetas, Theophrastus and Heraclidus Pontus appear to have had a knowledge of the rotation of the earth upon its axis: but, Aristarchus of Samos, and more particularly Seleucus of Babylon, who lived 150 years after Alexander, first arrived at the knowledge that the earth not only rotated upon its axis but also moved around the sun as the centre of the whole planetary system.

NONIUS, PETRUS—NUÑEZ, PEDRO—(1492–1577) was a celebrated Portuguese mathematician who, after a voyage to the East Indies, became chief cosmographer of the kingdom and made a great many improvements in astronomical instruments the results of which were recognised notably by Tycho, Brahe and by Dr. Halley. Of all his books the most important are the *Tratado da sphera*, 1537, *De arte atque ratione navigandi*, 1546, *Opera mathematica*, 1566 (containing many treatises on navigation, sailing cards, etc.), *Annotaçoes a sphera de Sacro Bosco*, 1567, *Instrumenta Artis Navigandi*, 1592. Stockler says that the last named (alluded to by Gilbert, Bk. IV, Ch. 8) is an amplification of the 1537 *Tratados das cartas de marear* and would alone justify placing Nonius among the most distinguished geometricians of his time.

NORMAN, ROBERT, who flourished in 1590, was a compass-maker of the port of London, living at Limehouse, "a skilled navigator and an ingenious artificer." He is the author of the *Newe Attractive*, 1581, already mentioned at the Hariot entry and wherein he gives an account of his discovery in 1576 of the dip of the magnetic needle as well as of the dipping needle which he invented. Gilbert (Bk. I, Ch. 1,: Bk. IV, Ch. 1, 6) states that Norman posits a point and place toward which the magnet looks but whereto it is not drawn: toward which magnetized iron, according to him, is collimated but which does not attract it: also, that Norman first strove to show that the cause of variation is not the result of attraction: that he originated the idea of the "poynt respective," looking as it were toward hidden principles, and held that toward this the magnetized needle turns and not toward any attractional point: "This poynt respective is a certayne poynt which the touched needle doth alwayes respect or shew."

OFFUSIUS, JOANNES FRANCISCUS—After Gilbert has stated that Offusius, in his treatise *De divina astrorum facultate*, 1570, distinguishes several magnetic movements: the first to the centre, the second to the pole traversing 77°, the third to iron, and the fourth to the loadstone, he adds that the first is not always to the centre, that the second is no movement, but a direction or a variation to the earth's pole, whilst the third and the fourth are magnetic and are but one movement. Thus, adds he, this author recognises no true magnetic movement, but coition toward iron or loadstone, commonly known as attraction.

OLAUS MAGNUS, a native of Sweden and archbishop of Upsala, where he died in 1568, is the author of the work, *Historia de gentibus septentrionalibus*, first issued in 1555. He is twice alluded to by Gilbert with regard to the magnetic islands which Olaus spoke of in this work, wherein he likewise states that there are mountains in the north possessing such power of attraction that ships have to be constructed with wooden pegs, so that, as they sail by the magnetic cliffs, there be no iron nails to draw out.

(*To be continued.*)

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Practical Notes on Induction Motors.

Their Installation and Maintenance.

By John S. Leese.

The nature of work for which an induction motor is best adapted is found in conjunction with steady loads which have to be carried at full or nearly full speeds. It is generally equally suitable for the work done by shunt-wound direct-current motors, and its efficiency and power factor show best when it is operated at or near full load and at a constant speed. The induction motor requires considerably less attention than does the synchronous motor, with which it is sometimes brought into competition. The effect of the induction motor on the circuit current is, however, detrimental to the power factor, causing, as it does, the current to lag behind the voltage. On the other hand, the effect of the synchronous motor upon the circuit current is to cause the current to lead the voltage under steady loads and with strong field excitations. Hence, therefore, if synchronous motors are wired into the same circuit as induction motors, the leading currents induced by the former will go some distance towards neutralising the lagging currents involved by the use of the latter type of motor. For full loads, long runs and unskilled attendance, the squirrel-cage motor is preferable to the shunt-wound machine, the latter being used for services involving frequent stops and starts and being indispensable in cases where incandescent lamps are supplied from the bus-bars.

The location of an induction motor requires to be carefully chosen to get the best practical operating results. The motor must be so positioned that it is easily accessible for inspection and repair, accessibility for these objects ensuring easy means for oiling and cleaning. The motor must not be exposed to moisture, steam, dirt or gritty dust, the effects of all these being bad for efficiency. In order to ensure the maintenance of the highest operating success, it is necessary to provide proper ventilation for the motor, either by placing it in an open position or in a strong natural draught, or by providing an artificial draught. When an induction motor is installed in an inverted position on a ceiling, or placed on a high wall bracket, it may be advisable to cut a trap door in the floor above, giving access to a suspended platform beside the motor for inspection work. This feature will, at any rate, ensure more efficient attention than the inspecting electrician would be ready to give to the motor if he had to hang off a high ladder to conduct his survey.

The foundations for induction motors which are either chain or belt connected to their work may be constructed of stout timber or concrete. The foundations must be sufficiently heavily constructed and tied to allow of no vibration in the motor. The foundations must also be such that the pulley axes are exactly parallel; if this provision is not fulfilled the motor will not "float" in its bearings but will run up against one end all the time. When an induction motor is mounted, for direct or gear driving, on a machine tool or on a structural steel foundation, the frame will be grounded. It has become standard practice to ground the frames of all induction motors, special ground wires being required where the foundation is of wood or concrete. The reason for this is to minimise the risk of shocks being given to workmen by the accumulations of static electricity which occur in insulated-framed motors.

Pulleys, gear wheels and chain wheels which are required to be mounted upon the shafts of induction motors should always be secured with gib-headed keys so that no difficulties and delays will be experienced whenever it is desired to remove these pieces. When a belt pulley is found to be slightly loose on the shaft, it is better practice to secure it with a feather key and set screws, since, if a taper key be relied upon, it will only aggravate the looseness unless it is exceptionally well fitted. When a geared motor is being set up, the pinion should not be driven on to the shaft so tight that the rotor conductors will be jarred out of position or otherwise damaged in driving it on. At the same time, the pinion should be a good snug fit on the shaft before the key is applied.

The distance between the pulleys of a motor belt drive must be enough to permit the belt to drive satisfactorily without excessive tension. The latter undesirable condition causes excessive bearing friction and hot running machinery. At the same time, the position of the motor with regard to the driven machine must be such that there shall be no belt slippage, the driving side of the belt being at the bottom, thus giving a greater arc of contact and, therefore, less belt tension, reduced friction and longer bearing life. The belt pulley crowns should be as nearly alike as possible in order that the belt will be kept central and straight-running. Except in the smaller sizes, spoked pulleys should be used in preference to webbed pulleys on induction motor shafts, the latter interfering with the proper ventilation of the motor to a greater or less extent. Many engineers advocate the use of paper pulleys for motor drives, claiming very reasonably that the reduced belt tension required by their use offsets any disadvantages which they may possess.

In lining up direct-connected motors, the shafts to be coupled must be in perfect alignment, which must itself be maintained by a sufficiently rigid foundation design. It being well-nigh impossible to obtain dead accurate alignment, flexible couplings are introduced between the motor shaft and the driven shaft. These may be of several well-known types, in which the flexibility may be provided either by a metallic spring or else by some such material as leather. In lining up geared motors, the shafts must be made exactly parallel and at the specified distance apart. Wooden foundations cannot be allowed for geared motors owing to the likelihood of the wood warping and the bolts wearing in the holes, thus causing disalignment between the gear wheels with consequent excessive friction, wear and noise. Even when the motor is mounted on a rigid metal foundation for gear driving, it is necessary to steady-pin the motor frame to the foundation in order to obtain perfect security of position. When worm gear, bevel or mitre drive is employed, it is necessary to provide a ball thrust bearing on the motor shaft to resist the unavoidable axial thrust which is set up by the gearing. If this precaution be neglected, the soft bearing metal in the motor boxes will be rapidly worn away and will tend to give trouble by overheating.

Motors are often required to be put in other than vertical positions. In such cases it is necessary to shift the shaft bearing brackets radially around the shaft so that the working of the lubrication arrangements will not be interfered with, the oil wells being vertically beneath the journals. The rotor should always be tested for central running after a motor has been installed other than vertically, in order that an equal air gap will be provided all round the motor between it and the pole faces. For this purpose a testing set should be used, consisting of two gauges, large and small, such that the difference in size between the two represents the limit of allowable error due to rotor eccentricity.

Where motors are employed for quick stopping services a brake is imperative. These brakes are usually of the contracting band variety, and are generally magnetically operated. If the brake is liable to be frequently requisitioned, heat radiating fins should be provided upon the brake drum which, like large pulleys, should be either spoked or well drilled out to permit the motor to receive efficient ventilation.

In assembling the motor on site, care must be exercised in handling the armature. This part should never be picked up with a rope or chain sling without a spreader to keep the sling from damaging the winding. Another point which is important in handling the rotor is that it should never be placed upon a hard surface without the interposition of a thick pad, unless it is supported clear of the floor by means of blocks under the shaft ends. Before putting the rotor in finally, clean all the oil wells and passages and give the shaft journals an application of oil before placing it in the bearings. See that the oil rings revolve freely and carry enough oil to flood the bearings, filling the oil well with the highest grade dynamo oil to such a height that the surface of the oil comes above the lowest edges of the oil rings.

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The size of the conductors is determined by the amount of the full load current. For all ordinary work both conductors and fuses should have a current carrying capacity of one-and-a-half times the full load estimated capacity; whilst for such work as elevator driving and other services involving heavy starting torques, the fuses and conductors should have at least two-and-a-half times the capacity estimated for full load current. For large motor feeders it is distinctly better practice to use several small conductors in parallel instead of one large cable, for this reason, that the inductive drop in one large conductor supplying a load with a low power factor is a good deal in excess of that induced by several wires of an equal total cross-section. For alternating-current work all the wires should be located in one large conduit; otherwise the drop will be prohibitively great, and dangerous heating of the conduit will very likely result. For open work the various lines of an induction motor circuit should be placed as near together as possible, consistent with the limits imposed by voltage and other circumstances, so that the inductive effect will be reduced by the close proximity of the conductors. It is bad practice to solder the leads to induction motors permanently, the extra expense involved by the use of knife-blade connectors being completely offset by the time which will be saved whenever the leads have to be disconnected for any reason. An essential condition in the installation of motors is the efficient insulation and protection of the live parts of the outfit, which must be carried out in such a manner that workmen cannot possibly come into contact with them accidentally, thereby avoiding the risks and compensation expenses accruing to electric shocks.

Turning now to the practical operation of induction motors, the starting up of some motors may be effected with full load torque by the application of full load current to the machine. Others, however, require twice or thrice the amount of full load current to effect a start under full load torque. Polyphase motors will start with a full load torque on a lighter current than will single-phase machines. This is advantageous because the high inductivity of large starting currents has a deleterious effect upon the steady regulation of the supply circuit.

In order to keep the amount of starting current down, resistances may be inserted in the rotor circuit at the time of starting, or the motor may be started on a lower voltage than that normal to the supply line. Some such provision is necessary with all single-phase motors and with those polyphase machines which are called upon to start under heavy torques. Small polyphase motors can be started simply by closing the main switch, as also can large polyphase motors starting under frictional or very light loads only. In these machines, which can be started by closing the main switch to the line, simple squirrel-cage windings are usually employed for the rotor; but for machines requiring a starting resistance it is necessary to modify the squirrel-cage type of winding somewhat to allow for the application of this.

When a starting resistance is employed there is a great deal of similarity between the starting of an induction motor and a shunt-wound direct-current motor. If, in starting a shunt-wound motor, the field and the rotor windings are both switched on to the line at the same time, on account of its low resistance the armature will take the major part of the starting current, the starting torque being considerably reduced by the magnetic reaction of the armature against the field. As soon, however, as the motor speeds up, the large starting current is decreased and the torque increased. It is more usual and satisfactory, however, to put a starting resistance in the armature circuit of shunt-wound direct-current motors. Similarly, in dealing with induction motors, the provision of a starting resistance in the rotor—or armature—circuit enables the motor to get its magnetising current and thus start with a heavy torque on it. When the machine has speeded up the resistance is cut out as in the case of the shunt-wound motor. If the resistance be mounted in the rotor it may be cut out by a collar sliding along the rotor shaft, actuated by a hand lever, thus shorting the rotor circuit.

Occasionally one finds the starting resistance separate from the motor, being cut in or out of the armature circuit by brushes which bear against contact rings, which in turn are connected to the rotor winding. A multi-pole double-throw switch may be wired into such a circuit, starting being effected by closing it on one throw, switching over to the other when the motor has attained its speed. The switch should never be thrown from the starting to the running position before the machine is up to speed, and should be marked "Starting" and "Running" at these positions to avoid confusion. Oil immersed starters are sometimes requisitioned in this service, being generally switches of the revolving type which make the proper connections in their correct order, the positions being marked on the hand-wheel or switch casing for "Starting," "Running," and "Stopping." In changing from the starting to the running positions the handwheel should be turned slowly or else excessive current may rush through the machine before the attainment of a suitable speed. Never leave the starting handle or switch of an induction motor in the starting position whilst the motor is connected to the circuit. The handle must be placed in the "Off" or "Stopping" positions when the motor is shut down.

Starting up an induction motor may be effected by employing a lower voltage than the normal line voltage, using a step-down transformer for this purpose which is cut out as soon as the motor has been brought up to speed and line voltage can be applied. A point to be noted in connection with a step-down transformer for this purpose is that it should, in kilowatts, have an equal capacity to the motor rating in horse-power. The low voltage method of starting may be utilised with advantage in cases where an induction motor is required to start with a friction or shafting load, the full torque being withheld from the shaft until full speed has been reached, as, for instance, in many machine shops and factories. The resistance method of starting is more applicable to elevator motors and similar services where heavy torque starts are called for.

Another way of starting an induction motor with a heavy torque is by lowering the frequency of the line current. The reason for this will be obvious when it is remembered that with reduced frequency the slip is considerably reduced at low speeds. This method is comparatively rarely applied, since it is seldom possible to reduce the frequency in a supply circuit. It can, however, be made use of where two induction motors are employed by connecting the stator winding of one motor in series with the rotor winding of the other, which will consequently start under a heavy torque, the first motor receiving its current with reduced frequency and therefore starting with a good torque also.

When a resistance is employed for speed regulation it may be left in the armature circuit as long as the operator likes, since it will, in this case, have been specially designed to carry full load current continuously.

The failure of an induction motor to start may be due to a variety of causes: broken wire; bad lead connection; main switch left open; overload on the machine; no current on the line; excessive bearing friction; fuse blown, etc. These points may also be the cause of stoppages during operation, failure to carry the load, or inability to keep up to normal speed.

In starting with the resistance method it is important to see that the resistance is not shorted before the main switch is closed, as the motor will take an excessive amount of current from the line and will probably refuse to start at all if it is.

Operating hints, in connection with the operation of induction motors equipped with a starting resistance which is introduced into the armature circuit by contact rings and brushes, may perhaps be of interest to attendants who have not had practical experience in this line. To get the best results, it is necessary to keep the contact rings thoroughly clean and the brushes so adjusted that they make proper contact with the rings when the armature is at rest, but clear them when full speed has been attained. As soon as the brushes have worn to such an extent that there is a danger of the brush-holders coming into contact with the rings, new ones should be installed, being sandpapered to the rings in order to secure a good and efficient face contact. A poor contact will entrain sparking at the brushes which will soon pit the rings to such an extent that they will have to be turned down to a smooth surface. A novice may be somewhat alarmed at the noise and amount

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of sparking which sometimes occurs at starting with this method of resistance application. There is, however, nothing to be alarmed at, since the noise and sparking will not last long and will stop as soon as the contact between the brushes and rings has been broken by the attainment of the normal rotor speed.

It is the writer's experience that the majority of induction motor troubles are caused by mechanical defects, so perfect has the electrical equipment been made. Improper lubrication will go far to make operation inefficient. Only the very highest quality of dynamo oil should be used in the bearings, the extra cost being completely overbalanced by the longer life of the lubricant and the reduced number of troubles due to the bearings and journals. Oil which has been drained off bearings once should never be used again without filtering; nor should oil be used in the bearings of electrical machinery after the second filtration. Leaky bearings, an excess of lubricant, failure in properly sealing the end-plates of the bearings, or the armature shaft being out of the horizontal, may all cause oil to find its way on to the armature windings to the detriment of the latter, tending, as it does, towards insulation breakdowns and short-circuits. Water also injures the insulation and must not be allowed to accumulate thereon.

Wear of bearings will lead, in time, to the rotor striking the stator core as it revolves, with consequent damage to the insulation of both parts. This state of affairs may be avoided by regular and efficient inspection, and, in conclusion, the writer will outline a plan whereby he has altered to favourable the opinion of several works managers concerning the satisfactory operation of induction motors.

An induction motor will stand up to its work under remarkably bad conditions and for a creditably long period. Neglect, overloading and careless oiling are bound to tell in the long run, however, and the expense involved in repairing and overhauling badly used machines is no light item. In all works where the writer has had jurisdiction in the matter, the motors have been inspected once a week by one of the best working electricians. The weekly duties of this inspector are to see that the oiling devices are operating properly and that the supply of lubricant is not allowed to run dry, to inspect all wire and starter contacts, including the controller fingers and mechanism, to test the air gap all round with limit gauges, and finally to wipe the motor down all over. In addition to the weekly cleaning, the motor inspector should blow the dust out of the windings and core with compressed air or a strong pair of bellows at least once a month, and as often as once a week if the motor is situated in a pattern shop or other very dusty location. The oil wells and ways should be emptied and thoroughly cleaned out once every four months. The works manager should provide a log sheet for each motor, to be filled in by the motor inspector at each inspection and initialled and passed by the foreman of the department in which the motor is located and by the works manager. The form of log sheet shown herewith is satisfactory from all view points.

Regarding the stock of parts to be carried for renewals and repairs to induction motors, these should comprise a good set of all the sizes in use of stator coils, carbon brushes, tension springs, brush pigtails, controller contact fingers, contact blades and clips, also a supply of transformer oil, fish paper and oiled linen. With a good stock in the works, the delays due to breakdowns may be reduced to a minimum, with a consequent great saving in time and money.

SPECIMEN LOG SHEET.

Dust to be blown out weekly. J.B.

Motor No. 7	H.P. 10 Revs. 800	V. 110 A.	Type: Crompton V.E. 7·5.		Work: Wood working machinery.		Situation: Pattern Shop.		
1	2	3	4	5	6	7	8	9	10
Date Insp'd.	Oiling.	Shaft J'nals and bearings.	Air Gap.	Wiring Connections	Starter Contacts.	Starter Mechanism.	Insp'r.	F'reman.	M'ger.
5/6/11	O.K.	O.K.	O.K.	O.K.	O.K.	Fitted one new brush.	A.B.	P.S.	J.B.
12/6/11	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.	A.B.	P.S.	J.B.
19/6/11	O.K.	O.K.	O.K.	Refitted motor leads.	O.K.	O.K.	A.B.	P.S.	J.B.
26/6/11	O.K.	over	over	O.K.	O.K.	O.K.	A.B.	P.S.	J.B.
3/7/11	O.K.	over		O.K.	O.K.	O.K.	A.B.	P.S.	J.B.
10/7/11	O.K.	O.K.	O.K.	O.K.	over	O.K.	A.B.	P.S.	J.B.

FACE.

1	REMARKS.
26/6/11	3 & 4. Bearings worn reducing air gap at bottom of motor to less than small gauge thickness. A.B.
3/7/11	3 & 4. Above to be renewed next week-end. A.B.
10/7/11	3 & 4. Re-babbited bearings on 8/7/11 O.K. 6. Fitted 2 new contacts and re-connected. A.B.

REVERSE.

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Technical Problems and their Solution.

QUESTIONS AND ANSWERS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways, and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for the next best, but in the case of two replies adjudged to be of equal merit, these two sums may be added together and divided. Replies should reach the office within seven days of the appearance of the questions.

QUESTIONS.

Problem No. 1271.—Explain—with theoretical justification—a method of measuring fault resistances, applicable to 3-phase or 2-phase 3-wire networks. Simplicity is important.—" QUERIST."

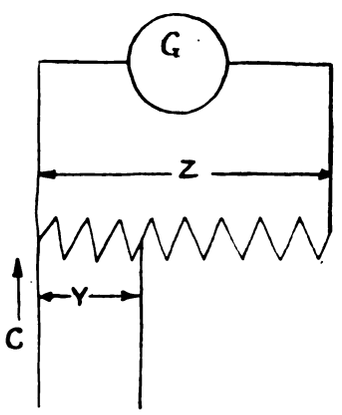
Problem No. 1272.—On a three-phase circuit of shaft cables there are two pumps; one a turbine the other a three-throw. Starting up the three-throw causes a wattmeter coupled to one phase (balanced load) to revolve in its correct direction. Starting the turbine one now causes the disc to slow down, stop, and revolve in the opposite direction. Turbine works at half normal head. Pressure coil of wattmeter is connected to a potential transformer phase to neutral.—" P. F."

Problem No. 1273.—A revolving-field alternator with direct-coupled exciter, driven by a direct-coupled steam engine is to supply a 90 b.h.p. 6-pole constant speed induction motor; the system being three-phase, 750 volts, 40 cycles. As the motor would start only twice a day, it is proposed to use a squirrel-cage motor connecting it to the alternator through a protective device, without any special starting apparatus; the motor to be started by running up the generating set. The alternator has average characteristics and the motor would have:—Speed 783 r.p.m., efficiency 92% and power factor 93% at full load. No-load current 12 amps, and stand-still current 302 amps. (at a power factor of 23·4%) per phase. Ratio of transformation 8·6. Stator star connected; resistance hot ·182 ohms per phase. Show the relation between torque of the motor and voltage, current, frequency, and power factor at starting; also state any objections to the scheme.—" SQUIRREL-CAGE."

ANSWERS.

Problem No. 1270.—When using a universal shunt in conjunction with a galvanometer it is best to have the total resistance of the universal shunt not greatly differing from that of the galvanometer, for if the resistances of galvanometer and shunt are disproportionate a loss of sensitiveness occurs. Explain the reason for this.—" BICKNOLLER."

Reply to 1270 (*in conjunction with No.* 1269) *awarded* 10s.—As these two questions deal directly with the same subject, I will treat them and their relation to one another in one answer. I would preface my remarks by a short note on the windings of galvanometer coils. With instruments of the fixed coil type, such as the Kelvin Astatic Mirror Galvanometer, it is usual to wind the coils in four, six, or eight sections and bring out both ends of the coils to terminals on the base, where they may be joined up by links to give the various possible series parallel grouping. In the case of moving coil instruments, a series of coils is provided, each of different resistance. It is no great departure from accuracy to make the assumption that the total amount of copper wound into each of the different coils of a moving coil instrument is constant—considerations of weight, space, and space factor will show this to be nearly true. If this be granted, then, if we have two coils for the same galvanometer, one (A) wound with wire of cross section a, and the other (B) with wire of cross section 2a, A will have twice as many turns as B, and four times the resistance, and, further, if we could by any means divide coil A into two parts, and put those parts in parallel, we could reproduce B both in number of turns and in resistance. The case, then, of the moving coil instrument is analogous to that of the fixed coil instrument, save that in the case of the moving coil instrument, in order to effect a rearrangement of the sections of the winding we have to substitute an entirely new coil.



Suppose now we have a galvanometer, G, wound with N separate turns, each of resistance R, shunted by a universal shunt of resistance Z and of portion Y. Let there be X turns of the galvanometer winding grouped in series, and therefore $\frac{N}{X}$ groups in parallel.

The resistance of each group will be RX, and therefore of the N/X groups in parallel $\frac{RX^2}{N}$

If C be the current flowing in the battery leads, the current through the instrument will be $CY \Big/ \frac{RX^2}{N} + Z$.

The ampere turns of the galvo winding will be current X turns in series or

$$\frac{CYX}{\frac{RX^2}{N} + Z},$$

or

$$\frac{CY}{N}\left(\frac{X}{RX^2 + NZ}\right)$$

The ampere turns are a maximum, and the sensitivity greatest when

$$\frac{d}{dX}\left(\frac{X}{RX^2 + NZ}\right) = 0$$

or when

$$RX^2 + NZ - X.2RX = 0$$

or when

$$RX^2 - NZ = 0$$

or when the resistance of the galvanometer is equal to the total resistance of the shunt.

It is important that the correct construction be placed on this result. The investigation shows that, if we have a given shunt, and a choice of coils, or of the arrangement of the windings, for our galvanometer, the most sensitive arrangement is that which brings the galvanometer resistance most nearly equal to the shunt resistance. The investigation does not show, what indeed is erroneous, that with a given galvanometer, the best shunt is that whose resistance is most nearly equal to the galvanometer resistance.

Turn now to the case of the 800 ω galvonometer and its various shunts. If the sensitivity is 150 m.m. per micro

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ampere at metre scale distance, with a scale of, say, 500 parts, the observer, even though testing with 500 volts, would be hard put to to measure 50,000 megohms. In any case the maximum sensitivity will be required, and this is obtained with the 100,000 ω shunt. With this shunt, the maximum current through the galvanometer

$$\frac{100{,}000}{100{,}800}$$

or 99·2% of the battery current. This would be obtained with the whole of the resistance (100,000 ω) in the shunt circuit, and this position could very well be marked 1/1 With the 10,000 ω shunt

$$\frac{10{,}000}{10{,}800}$$

or 926·% of the battery current will pass through the galvanometer in the extreme position, and with the 1,000 ω shunt but

$$\frac{1{,}000}{1{,}800}$$

or less than 60% of the battery current. If now a new coil could be obtained for the galvanometer of, say, four times the resistance, or 3,200 ω's, the number of turns, and the sensitivity, will be doubled. The galvanometer current would fall to

$$\frac{100{,}000}{103{,}200}$$

or 96·9% of the battery current, and there would be a net increase in sensitivity of 97·7%. This increase would continue, as we have seen, until we reach a galvo resistance of 100,000 ω's, when the galvanometer current would be reduced to

$$\frac{100{,}000}{200{,}000}$$

or 50% of the battery current, and the sensitivity increased

$$\sqrt{\frac{100{,}000}{800}}$$

or practically 11 times, giving a net increase of sensitivity by 5·5 times.

The objection to the use of so high a resistance shunt is the comparatively large changes in the combined resistance of the galvanometer and shunt. In this case, however, this combined resistance is quite negligible compared with the outside resistance.

Shunt	Resistance of Combination.	Minimum External Resistance.	Percentage Error.
1	793 ω.	100 meg.	8×10^{-4}%
10	9000 ω.	10 meg.	·09%
100	1000 ω.	1 meg.	·1%

as the above table shows.—J. F. FORREST.

PHYSIOLOGICAL EFFECTS OF ELECTRIC SHOCK.

According to Doctors Krida and Stanton in, the New York State "Journal of Medicine," the chief causes of death from electric shock are undoubtedly "fibrillary" contractions of the heart, and respiratory paralysis. By the former are meant inco-ordinate contractions of the individual muscles of the heart, resulting in complete derangement of its normal rhythmic beat. Respiratory paralysis seems to be identical with the results of an overdose of an anæsthetic. Respiration may continue, and consciousness be preserved, in cases of fibrillary contractions, till anæmia of the nervous system causes death, but, if the action of the heart be unimpaired, respiration can frequently be artificially restored. As yet there is no known reliable means of restoring the normal action of the heart once it is deranged; on the other hand, if the respiratory organs are alone affected, prolonged artificial respiration enables a considerable percentage of recoveries from apparent death.

The conflicting results reached by many investigators, as to the physiological effects of electric currents, are chiefly attributable to the different forms of current employed and the diverse experimental conditions. The following remarks apply to cases of shock from circuits carrying amounts of energy such as are used in ordinary commercial work. The current passing through the body of the victim probably varies between half and 10 or more amperes.

The effects produced by direct and alternating currents vary directly with the current strength (and hence with the applied voltage), with the duration of contact and with the path of current flow through the body. The frequency of alternating currents is of great importance, low-frequency currents being usually more dangerous than high-frequency currents of the same strength.

Paralysis of the heart is especially liable to result from low-pressure currents, particularly if the heart be in the path of current flow; respiratory paralysis, however, usually follows on anæsthesia of the central nervous system set up by high-pressure currents. Actual destruction of tissues by burning occurs only at the site of high-resistance contacts, and is of minor importance as a cause of death; nevertheless the tissues often slough far beyond the apparent limits of the burn. In cases of accidental shock, the body often serves merely to complete the path of a high-pressure arc.

In general the lower animals are more susceptible than human beings to electric shock. Whereas 70 volts D.C. is often fatal to dogs, 100 volts scarcely affects a normal man, 200–400 volts produces muscular cramp, and 550 volts produces almost instantaneous respiratory failure. Low-pressure A.C. shocks are liable to cause fibrillary contractions; 600 volts causes fibrilations and respiratory paralysis, but 2300–4800 volts usually affects respiration alone (in such cases artificial respiration should be persevered with, for hours if necessary). The medical reports of the U.S.A. electrocutions since 1890 show that a few seconds flow of 2 to 7 amperes (at 1.500 volts,15 to 50 cycles per sec.), may not cause death, but with an application of 45 to 50 seconds' duration, the heart's action is permanently suspended.

THE ENDURANCE OF STEEL.

At a recent meeting of the Birmingham Local Section of the Institution of Electrical Engineers, Professor Gisbert Kapp, past-president, gave a demonstration of his magnetic machine for testing the endurance of steel and other metals. He said that ever since Woehler's time, now half a century ago, it was known that metals become fatigued, that is their strength is diminished if subjected to rapid repetition of stress. Steel might support quite safely a load of 15 tons to the square inch if continuously applied, but if such a load were repeatedly put on and taken off the steel would become fatigued and finally break. Machines for putting alternating loads on test pieces were also well known, but in the machine hitherto used the application of the test load was purely mechanical and could therefore only take place at a moderate frequency. If the problem was to find the effect of some millions of applications of stress the process naturally took a very long time. In the machine which was exhibited to the meeting the application of the stress was by means of an electro-magnet energised by an alternating current at the rate of 100 stresses a second and it was thus possible to subject the test piece stress applications in about 3 hours. The time to find out whether or not a material was suitable for machinery where high speed and great mechanical stresses occur was thus considerably shortened. By testing samples of steel, iron and copper for strength, Professor Kapp found that in only two samples of common iron could any fatigue be discovered when the stress was kept within the moderate limits of 5 to 6 tons (3 to 4 tons for copper) per square inch, although some of the samples were subjected to as many as 15 million stresses.

If, however, the stresses were raised to the values which in modern high speed and lightly built machinery prevailed the effect of repeated application became very noticeable; in other words, there was fatigue. He showed a test piece of steel which in a length of 3 in. had under the repeated applications of a stress of only 15 tons to the square inch lengthened by $\frac{1}{16}$ in. and would if left in the magnetic machine have undoubtedly broken under that stress. The machine was just stopped in time to prevent actual rupture. Yet only 180,000 stresses had been applied to this test piece. A test piece of the same steel which had not been treated in the magnetic machine broke in the ordinary testing machine with a load of 26 tons to the square inch. It was thereby clearly demonstrated that fatigue is a real danger, if the material is subjected to fairly high and often repeated stresses of 5 or 6 tons to the square inch, there is practically no change in the strength of the metal no matter how long it has been in service.

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Electrical Progress at Home and Abroad.

UNITED KINGDOM.

Lighting, Power, Telegraph, Telephone, and General Business Notes.

BIRMINGHAM.—The City Council, on the recommendation of the Electric Supply Committee, have decided that in place of the extensions at Dale End sub-station, sanctioned in March, 1909, the Committee be authorised to provide a storage battery at a cost of £13,110, and necessary, buildings at a cost of £12,130. It was also recommended that, in lieu of the sub-station at Harborne, a sub-station be erected in War Lane at a cost of £9,515. It was also decided that a plot of land be acquired in Percy-road, Greet, at a cost of £275, as a site for an electric sub-station; that high-tension trunk mains be laid connecting the Summer-lane and Aston Manor generating station, at an estimated cost of £5,500, and to provide two rotary converters and transformers at the Aston Manor Station at a cost of £7,531; that induction motors and converters be supplied at the Handsworth Station at a cost of £4,428, and high-tension trunk mains be laid from the Summer-lane generating station to the Handsworth Station at a cost of £6,000.

BRIGHTON.—By twenty votes to twelve the Town Council has rejected the assisted wiring scheme prepared by Mr. J. Christie, engineer and manager of the Electricity Works, and adopted by the Lighting Committee. Councillor Skinner urged that when such an agreement as was proposed was entered into the payment for the installation was by means of a slot, and therefore would be by the tenant. The owner agreed to buy the installation and the tenant paid for it. To whom would the installation belong when the payments were completed? If the tenant who adopted the system came to the conclusion when he had made one or two payments that he would rather revert to gas, and therefore disconnected the electric lighting system and went back to gas, what became of the installation? Finally, as the installation did not belong to the tenant until he had completed his payments, who would have to pay for renewals of lamps? Councillor Booth referring to the recommendation that the engineer be authorized to purchase one dozen Ferranti fires at a cost of 84s. each for the purpose of letting them out on hire, said they would get only 14s. per year for an expenditure of about £3. After the fires had been in use for twelve months by a tenant, another might come in and decline the old fire. Were they going to scrap it? Councillor Braybon moved the rejection of the report, and this was seconded in several places. Councillor Campbell said as to the tenant paying and the landlord owning, it was obvious the tenant could make any bargain he pleased with the landlord with regard to installation. With regard to renewals, the agreement itself made that quite plain; after being tested and connected, the cost of maintenance was to be borne by the owner or consumer. It would not be paid either by the contractor or the Corporation. They were running no risk in collection, because it was by prepaid meter. Councillor Braybon's amendment, however, was carried by a majority of eight in a gathering of 32.

ELTHAM.—On the recommendation of the Electricity Committee of the Woolwich Borough Council, it has been decided to improve the pressure in a portion of the area of supply in Eltham and to extend the mains at a cost of £55.

HAMPTON COURT.—Under instruction from H.M. Office of Works, an installation of sixty electric fire alarms is being made at Hampton Court Palace for the protection from fire of the treasures stored there, while another precaution against fire is the laying of a 15-inch pipe from the 42-inch main of the Metropolitan Water Board in Hampton Court-road to the east and south fronts of the Palace. At these points the pipe will be connected with the branch mains in the Palace, which at present serve for fire protection.

HOLYHEAD.—The Urban Council has decided to reduce the rate to private consumers from 5d. to 4½d. per unit, and to increase the cost of public lighting to 4½d., both scales to come in force as from March 31.

KIRKHEATON.—The whole of the central districts of Kirkheaton, near Huddersfield, are now lighted by electricity. The current is conveyed from the central station of the Kirkheaton and Lepton Electric Light and Power Supply Company by overhead wires affixed to steel poles.

NEWCASTLE.—The "Shipping Gazette" states that an important repair job has just been executed on the Tyne under conditions which are calculated to serve as an object lesson to the boilermakers who threatened to strike over the discharge note question. A steamer came to the river with a broken stern frame, and it was necessary that this should be repaired with the greatest despatch. The repairers, face to face with a strike of their men, would have been unable to undertake the job but for their determination to try a new patent electric welding process. This was promptly brought into requisition, and by its means the stern frame saw successfully welded together without being touched by the boilermakers at all. The steamer sailed away to time, and the owners are said to have saved £1,200 as a result of the experiment. This electric welding process, adds the "Gazette," is likely to be a good thing for ship-repairers now that its efficacy has been practically proved.

NORWICH.—At a meeting of the Town Council it was resolved to accept the tender of Messrs. Babcock & Wilcox, for overhead coal-bunkers, conveyor, induced draught fan, crane, grab, provision for dampers, and sundries, for £3,495, and for two new boilers, with superheaters and mechanical stokers for £3,450, and old boilers, be accepted, subject to the following terms of payment, i.e., £2,315 on completion, £2,315 one year after completion, and the balance two years after completion. The plant that was now proposed to be superseded with more modern requirements was some of the old plant that the city had taken over from the company; and so one could truthfully say of it that it had done its duty. It was no longer fit for the extended requirements of this constantly extending department. The expansion of the business required this outlay, which would be paid for entirely out of revenue, so as to avoid the expensive plan of raising money at a heavy rate of interest. Arrangements had been made with the contractors by which the payment of this money would be spread over three years. There was no interest to pay on these deferred payments; and this was a subsequent arrangement made after the tender—the lowest tender—was in.

SIDMOUTH.—A meeting of ratepayers approved, with two or three dissentients, the proposal of the Urban District Council to purchase the undertaking of the Sidmouth Gas and Electricity undertaking; and a Bill will be introduced into the present session of Parliament with that object.

WILLESDEN.—Mr. J. G. Bruce, Electrical Engineer to the District Council, has issued a circular to consumers announcing that the Council have decided to reduce the present flat rate charge for electric light from 5d. to 4d. per unit from the date on which the final reading of the meters for the Christmas quarter was taken. The circular also draws attention to the low price charged for electricity used for heating and cooking, namely, 1½d. per unit if separately metered, and offers to send an assistant to call and give consumers any information they may desire.

TRACTION NOTES.

BIRMINGHAM.—A deputation has waited upon the Tramway's Committee of the Council to urge a modification of the proposed tramway extensions in the Acochs-green district. The committee's scheme was to run a

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tramway along Warwick-road to the terminus at the junction of Westly-road, Shirley-road, and Warwick-road. The deputation asked the committee to fix the terminus short of that junction, namely, at Fox Hollies-road, where it would unite with the proposed ring road, and it was pointed out that inconvenience would arise if the tramway were carried to the junction of the three roads, and also that serious depreciation must ensue to the property on the line of route, more especially in the cases of those houses where it was proposed to acquire an important portion of the front gardens for the purpose of widening the roadway. Many of the buildings, it was urged, would be ruined by the curtailment of the frontages, and it was estimated that the depreciation of the residential property would amount to at least £10,000. The committee promised that the points raised should have full consideration.

BRIGHTON.—The Town Council has approved the proposal to promote a railless traction Bill in the next session of Parliament. Alderman Wilson in moving the resolution of approval said the proposed system would be more efficient, regular, and cheaper, the roads would be no more cut up by the trolley omnibuses, and perhaps rather less, than by motor-omnibuses, and as to the overhead wires people would soon get used to them. Their roads were not too narrow for the system, and they were of the opinion that there would certainly be no extra burden upon the ratepayers. They had the assurance of their advisers that there would be a large surplus which would go to the relief of the rates. The confirming resolution was carried without a single dissentient.

EASTBOURNE.—Lord Willingdon, responding to the toast of "The London, Brighton and South Coast Railway," of which he is a director, at the annual railway dinner at Eastbourne, said he looked forward to the time when electric trains would run between London and Brighton, and Eastbourne. This could only be brought about by the directors receiving the constant and zealous support of every class and grade under the railway system. His lordship paid a warm tribute to the loyalty of the men during the late strike.

ILFORD.—At the exits of the Corporation's electric cars, boxes have been fitted for the reception of used tickets in order that the customary litter may be avoided. Passengers after the first few days have fallen quite naturally into the use of these receptacles.

ST. PANCRAS.—The Borough Council has decided to oppose the London County Council's Tramways and Improvements Bill, on the ground that the proposal to construct a tramway along the Euston-road should be deferred pending a decision as to the widening of the thoroughfare throughout its entire length. The London County Council's proposal is to link up the existing tramways at King's-cross and Hampstead-road, but the Borough Council has already refused its consent, as a tramway along Euston-road would limit the space available on either side of the outer lines, and would cause serious congestion of traffic. The Highways Committee of the London County Council recommended that the resolution to construct the tramway should be rescinded, but it was not carried, the voting being equal. The intention of the County Council with regard to a portion of the Euston-road was to cut off a portion of the existing footway in order to provide the necessary space of 9 ft. 6 in. between the outside of the footpath and the nearest rail of the tramway.

SOUTHALL.—The Southall, Hounslow, and Twickenham Railless Traction scheme is to be opposed by the London United Tramways, Ltd., who have presented a memorial to the examiners of private Bills complaining of non-compliance with the Standing Orders. The memorial specifies clauses in the Bill which, it is alleged, contain powers of which no notice was given last November.

WORTHING.—At a special meeting of the Town Council it was unanimously resolved to oppose the Bill promoted by the Brighton, Hove, and Preston United Omnibus Company to run overhead trolley 'buses between Brighton and Worthing. Alderman White (Chairman of the Legal Committee), in voicing the opposition, said the company's Bill proposed to take the trackless system from the eastern boundary of the borough along Brighton-road, Warwick-street, South-street, to the Pier, continuing westward to Heene-road. There were powers asked for which would give the company the right to run in other streets, and the streets would be decorated—or otherwise—with overhead equipment of wires, probably interlaced. It was proposed to make the Pier a terminus, and that meant that the wires and the overhead equipment would, at that prominent spot in the town, be perhaps doubled. There was a type of motor 'bus running upon some roads which provided practically all that they could desire. It was noiseless, commodious, not bad looking, and w s certainly very convenient. If they could have some such system as that between Worthing and Brighton it would have the universal approval of the members of the Council.

SCOTTISH NOTES.

Electricity versus Gas—Mr. Milne's Humour and Mr. Bell's Retort—Modern Electrical Applications.

Readers of the ELECTRICAL ENGINEER may remember that in the spring of last year Mr. Samuel Milne, the Aberdeen gas manager, in a report concerning certain types of gas burners erected for experimental purposes at certain points in the town, mentioned in an incidental manner, as if it were quite a matter of common knowledge, that "for public lighting, gas was superseding other forms of lighting in London, in the provinces and in the leading cities of the Continent." The statement—and especially the categorical, authoritative and off-hand manner in which it was made—aroused at the time a good deal of banter at Mr. Milne's expense; and the incident was then apparently forgotten.

The matter has now been revived in the form of a report by Mr. J. A. Bell, the electrical engineer, who deals in detail with the experiments made in lighting in Albyn-place when Mr. Milne's lamps were tested in comparison with electrical illumination, and with flame arc lighting in Union-street and other localities. In the experimental lighting of a portion of Albyn-place by means of metal filament lamps, ten clusters of lamps were erected, suspended by means of wire from the tramway overhead span wires. The capital cost of erecting a three-lamp cluster on each span in Albyn-place equalled £47 3s. The value put upon the gas posts to be removed was, as shown in the gas engineer's report of March 31 last, 36s. each; therefore the value of the 31 posts equalled £55 16s. There would, therefore, be a balance in favour of the department of £8 13s., which would more than meet the cost of removal.

Mr. Bell goes on to say that from the 1910–11 accounts it appeared that the cost of gas for public lighting was £4,715 15s. 7d., and the cost of lamplighters' wages, renewals of globes and burners, mantles, and repairs, for gas lamps was approximately £4,425. Remembering that a large proportion of the public gas lamps were still flat-flame burners, in view of the above figures, it could at least be assumed that an equal sum was paid for men's time, mantles, etc., as was paid for gas consumed in each incandescent gas lamp. The cost per annum of 31 gas lamps in Albyn-place, each taking 3½ cu. ft. of gas per hour, at 1s. 9d. per 1,000 cu. ft., and allowing for 15 lamps burning 3,600 hours and 16 lamps burning 1,400 hours, was £23 7s. 11½d., to which must be added at least an equal sum for mantles, men's time, repairs, etc. This gave a total of £45 15s. 11d. The annual cost of electric lighting of Albyn-place by means of the three-light clusters of 150 c.p. each, including current, men's time, lamp renewals, and capital charges equalled £69 3s. 6d. The candle-power of the gas was claimed to be 70 for each lamp, whereas the average certainty did not exceed 45, except immediately after new mantles were put in. The candle-power of the three-lamp clusters was still 150 each after the lamps had burned 1,400 hours. In view of the claim put forward by the gas engineer that the experimental gas lamps in Fountainhall-road were each of 240 c.p., Mr. Bell urged that the committee should make a comparison between them and the Albyn-place lamps, which gave actually 150 c.p.

Finally Mr. Bell clinches the matter by means of a definite challenge. "I wish," he says, "to take this opportunity of repeating what I said to the lighting sub-committee after having seen the gas engineer's report dated March 31. The statement therein made as to gas superseding other forms of lighting is a most misleading one and I am prepared to give ten towns which have installed electricity in place of gas for every one which Mr. Milne

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can bring forward as having changed from electricity to gas." As regarded the flame arc lamp, there had been 31 on trial for a period of 2½ months. These lamps burned on an average between 70 and 80 hours without re-trimming. A sufficiently extensive trial had been made to recommend the types to be adopted if the committee decided to instal any of these lamps. Mr. Milne's reply is now awaited with some interest.

Applications of Electricity.

At a meeting of the Royal Scottish Society of Arts, at Edinburgh, Mr. C. Norman Kemp, B.Sc., delivered last week an address on the Modern Applications of Electricity, in the course of which he assigned the real dawn of the electric age to the last quarter of the nineteenth century, and referred especially to the Electrical Exhibition in Paris in 1881, and at the Crystal Palace in the following year.

At both of these gatherings, said Mr. Kemp, there were brilliant displays of arc and incandescent electric lighting, and the previously supreme position held by gas as an illuminant was seriously menaced. It received, however, in the nick of time, a new impetus through the invention of the Welsbach incandescent mantle, which enabled from 10 to 20 times the former amount of light to be obtained for the same consumption of gas, and soon the further important improvements in high and low pressure gas lighting in turn threatened the carbon filament electric lamp with extinction. Then, early in the twentieth century, came the invention of the metal filament, which enabled more efficient lighting to be obtained at about one-third of its former cost, and now the position of incandescent electric lighting appeared unassailable, as economy was combined with its many other important advantages. The improvements in electric generators and in arc lighting were soon followed by the discovery of the possibilities of the electric furnace and of electrolytic methods of manufacture. To the electric furnace they owed, among other substances, calcium, carbide, now indispensable to the motorist; salica ware, which was taking the place of the costly platinum vessels formerly used; and carborundum, the valuable abrasive, exceeded in hardness only by the diamond.

Mr. Kemp then referred to some of the exhibits at last year's Electrical Exhibition at Olympia, and said that the display of the British Aluminium Company, Limited, was a revelation of extraordinary progress, for while aluminium in combination was widely distributed in nature, it had never been discovered in the native state, and so late as 1886 was sold at several shillings per ounce. During the last decade of the nineteenth century, in which its electrolytic manufacture was fully established, the world's production increased from approximately 200 to over 7,000 tons, and aluminium had become a formidable rival to copper in its applications to the electrical industry, for overhead and other power transmission lines, and in electric power stations. They owed much, also, to the inventive genius of Edison, and it was no surprise to learn that he had recently perfected an entirely new form of storage battery as the result of nine years of patient labour and research. In the Edison cell lead plates and sulphuric acid gave place to nickel and iron plates with an electrolyte of caustic potash solution, and it was claimed among other points that for cells of equal capacity the nickel type weighed about half as much as a lead cell and was of superior durability. In addition, the Edison cell might be completely discharged or short-circuited without damage. That form of battery would seem to open out a new future for electric carriages.

GERMAN NOTES.

The Hygiene of Electric Lighting—A Conclusive Experiment—New Railway Projects—Company Affairs.

Herr Wiekander has delivered an address to the International Congress for house hygiene at Dresden. He shows the advantages of electric lighting in maintaining the purity of the air, owing, of course, to the fact that it gives light without combustion, so that there is no carbon dioxide found. He experimented with six different lamps, and the results, so far as they can be numerically expressed, are contained in the following table:—

Lamps used.	Hefner candle power of same.	Heat units developed per hour.	Litres of CO_2 given off per hour.
Petroleum	15	480	70
Incandescent spirit lamp ..	65	698	119
Incandescent mantle gas lamp	74	573	59
Carbon filament electric lamp..	16	53	none
Tantalum electric lamp ..	25	35	none
Tungsten electric lamp ..	25	22	none

Herr Wiekander suggested that the problem of cost, the main factor in the introduction of electric lighting can be solved if the supplying companies will instal the fittings gratis or for a small sum in instalments, it being agreed that a minimum consumption of current shall be guaranteed for the first year. By this device, 6,200 small dwellings have been electrically lighted in Strasburg during the last 18 months. The system has doubtless a great future in large towns, say, for example, Berlin, where 35% of the population is housed in 200,000 two-roomed dwellings.

New Projects.

The preliminary works on the Nister valley dam are now complete, and permission has been given to finish the project. The reservoir will hold 9,000 million gallons. The power is intended to supply the whole of the Westerwald. The power house is to be at Flogert. The cost will be about half a million sterling.

A main line electrification scheme which is by far the largest of its kind in the world, is now far advanced. We refer to the State Railway from Magdeburg to Leipzig and Halle. The whole line will be opened in the course of 1913. Two experimental stretches, an ordinary one between Dessau and Bitterfeld, and a mountain railway at Lauban, have answered perfectly. Electric locomotives will be used, so that steam trains may be hauled on the electrified lines on leaving ordinary connections. Passengers will not have to change into motor coaches, nor will there be any need to tranship goods on arriving at the beginning of the electric railway.

At the meeting of the State Railway Department, on December 9, 1911, the question of electrifying the lines was considered. The Minister reported that the Government were continuing their enquiries as to the ways and means of getting sufficient water power at various points for generating the necessary current. Unfortunately, these researches have already proved, at least to the satisfaction of the present authorities, that it would not pay to electrify the Trieste-Ppiena line, the country being unfavourable and the traffic comparatively small. A decision will soon be arrived at as regards the Arlberg line.

Company Affairs.

The Geraer Strassenbahn A.G. is increasing its capital by 330,000 marks to a million and a half, and has changed its name to Geraer Elektrizitatswerk und Strassenbahn A.G. A dividend of 5½% for last year is to be paid on the old capital.

The Societe Norwegienne de l'azote et de forces hydro-electriques, which has just entered into a new agreement with the Badische Anilin und Soda Fabrik, and has absorbed two smaller concerns, has published its report for the first half of 1911. The experience with the new large furnaces has been very satisfactory. The company can barely fill its orders, and prices show a tendency to rise. The power station at Lienfos is in full work and are supplying 15,000 h.p. more to the works at Notodden. The reserve central station at the Svaelgfos is approaching completion, as are the works connected with the lake at Naarvand. And yet the water power available is not fully utilised. The net profit for the half-year is 323,894 K. This, with a carry over of 127,376 K., gives an 8% dividend on the preference and a 5% dividend on the ordinary shares, with an increased carry over, viz., 132,359 K.

A company for advertising with electric light has been formed in Berlin under the title of Continental Elektrograph, G.m.b.H. The capital is £25,000. Certain patents for electrically lighted signs called elektrographs and belonging to Herren Lindenstaadt and Poculla will be acquired.

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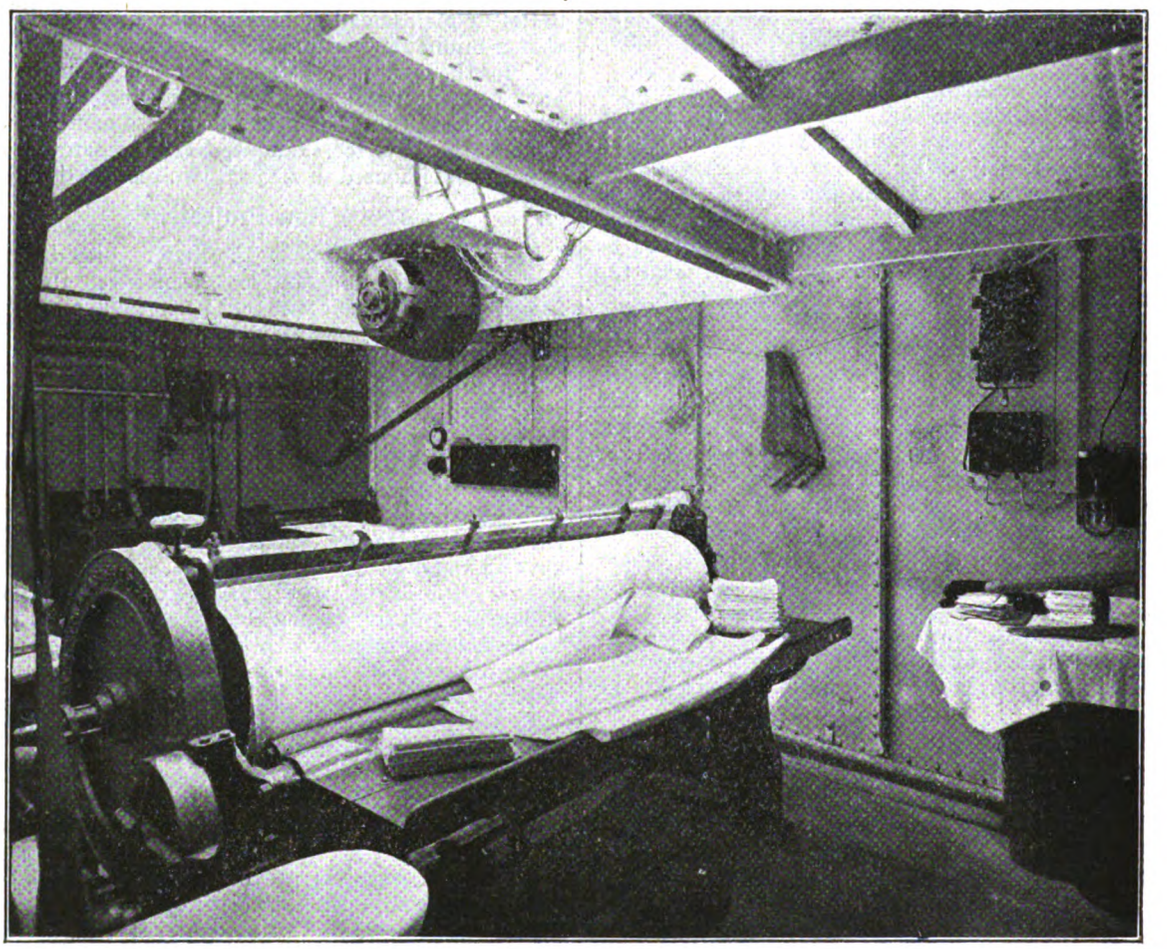
ELECTRICAL EQUIPMENT OF LAUNDRY ON BOARD S.S. "MEDINA."

We have been able to secure an interesting description of the electrical equipment of the laundry on board the s.s. "Medina," which conveyed their Majesties the King and Queen to India for the recent Durbar. Our illustration of the ironing room shows a standard semi-enclosed continuous current "Witton" motor driving the ironing machinery.

The motor is shunt wound and of the interpolar type, capable of developing 6 b.h.p. on 105 volts at 850 r.p.m., and to economise space is fixed in an inverted position. Supplied with above motor was a G.E.C. motor panel comprising D.P. Salford switch and fuses and suitable double automatic starting switch. The ironing machinery—manufactured and supplied by Messrs. Thomas Bradford & Company—comprises a 90 in. ×24 in. "Decoudun" machine for ironing table linen and flat work and a smaller machine of the "Mirror" type which is specially used for ironing shirts, collars, and cuffs. The larger machine consists of a concave ironing bed with a steam heated roller working therein. A second G.E.C. "Witton" motor to exactly the same particulars as above was also supplied for driving another room. We are indebted to Messrs. Thomas Bradford & Company for the use of the illustration given herewith.



ELECTRICITY AND A TRANSPORTER BRIDGE.

Bridge building was one of the earliest problems of the civil engineer, and a review of the bridges of the world, ranging from the primitive structures which span the fissures in the mountain tracks of India to the latest creations of man's scientific skill, such as the bridge over the Victoria Falls, would be a work of great interest. It is, however, the purpose of this note to show how electric power has been made available for use in connection with one of the latest bridges of note which has been built, and which includes some novel features of design. We refer in this connection to the transporter bridge which has recently been erected over the River Tees, which, as it has been working for some little time, gives ample demonstration of the value of electric power in connection with this service.

The bridge is one of a series of structures of the transporter type, the first of which appears to have been at Bilbao in 1889. This was followed in 1897 by a bridge over the Seine at Rouen, while in 1898 a transporter bridge was built at Bizerta, and another in 1899 at Martrou, and also one at Rochefort. In 1903, the first British transporter bridge was erected over the Mersey between Widnes and Runcorn, while in the same year a transporter bridge was built at Newport in Monmouthshire. More recent bridges are those which have been erected at Nantes and Marseilles in France, and at Duluth in America. The longest span or length between the towers or columns is that at Widnes, which attains 1,000 feet. Next to this structure is perhaps the one now at Middlesbrough, as the greatest overall length is 850 feet, the length between the spans being 570 feet, although the bridge at Newport has a longer length between columns, reaching to 644 feet, with an overall length of 770 feet. The height of the columns or towers at Middlesbrough is 225 feet, this being exceeded by the Newport, Nantes and Marseilles bridges only. The dimensions of the car are 44 feet by 39 feet, that at Widnes being 55 feet by 24 feet, and the weight of the Middlesbrough car is 184 lbs. per square foot, this loading being lighter than any of the others except those at Bilbao and Bizerta. The length of each cantilever girder overhanging at each side of the towers is 140 feet, and there is a difference of level between high and low water mark of 17 feet, the height of the under side of the girders given above being measured at low water. The extreme height of the bridge is attained at the top of the main posts of the cantilever girders and is 225 feet above high water mark. The foundations were sunk to a depth of 90 feet below high water at the Port Clarence side and 70 feet at the Middlesbrough side, steel caissons being sunk to this depth, and the towers for the support of the superstructures being built upon these. The foundations were filled up solidly with concrete, including the retaining wall support, the amount of concrete used in the foundations was 10,000 cubic yards. The total amount of steel work in the foundations is 600 tons, while the steel work in the bridge reached a weight of 2,600 tons.

The bridge is built on the cantilever principle, the extremity of the main span being anchored and secured to

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concrete anchorage blocks on each side of the river, sixteen wire ropes being employed, each capable of standing a breaking strain of 300 tons. From the main span a travelling car is suspended, and the floor of this is level with the roadway on either side of the river.

The travelling car is constructed for accommodating both passengers and vehicles, and has accommodation for 500 to 600 passengers and six vehicles. It is designed to travel from shore to shore in under two minutes, and the car is moved by means of an endless rope driven from a winch drum fixed in a winch house on the Middlesbrough side. To the winch drum is bolted a steel gear wheel, which is driven by a phosphor bronze pinion. The drum is electrically driven, this latter pinion being keyed to the motor shaft at each end of which is coupled by means of a flexible coupling a 30 h.p. series wound motor. Considerable care has been taken in order to ensure prevention of stoppage of the car in the event of the failure of any electrical portion, and also in order to obtain easy handling of the gear. The two motors are in series across a 450 volt direct current supply obtained from the Middlesbrough Corporation, and should one fail it can be quickly replaced by a substitutional resistance. In this way as one motor is sufficiently high powered to drive the car at a reduced speed, it is extremely unlikely if not impossible for the entire operation of the car to be interrupted by failure of the electrical gear. This point will be referred to again in a further paragraph.

On the pinion shaft there are two drums, the straps of which are normally held off by a magnetic solenoid and released by one of the brake stops of the controllers. In addition to this the controllers are furnished with two motor braking stops. Leading from the winch house are three core bitumen insulated cables running up to nine trolley wires which pass across the river above the carriage. This carriage, besides the compartments for passengers and vehicles, is surmounted by a pilot cabin on the top of the car, in which the controller for the motor is fixed. On the roof of the carriage are nine trolleys, each of which consists of a light carriage spring, which forces the arm vertically upward, this arm carrying two trolley wheels, which come into contact with the trolley wires. From the trolleys bitumen insulated cables pass down to the controller. Should from any reason the trolley wires of the pilot car controller or any other electrical portion outside the winch house fail, there is a spare controller in the winch house connected to safety interlocking switches on the winch house switchboard, which prevent the shore end controller being worked when the current is on the trolley wires. In this way the car can be on emergency be worked from the shore end. Both in the pilot house on the top of the car and in the winch house an ammeter and voltmeter are provided in order to control the driving and a separate lighting circuit for lighting the car passes from the winch house by means of trolley wires in precisely the same manner as the supply of the power circuit. The car at first took about 30 h.p. to drive it, but after a few weeks of steady running it was found that this power demand was somewhat reduced.

It will therefore be seen that, considering the system from the winch house switch board forward to the car, some very careful arrangements have been made to see that interruption or breakdown does not materially affect the operation of the bridge, but there is still a chance that the supply from the electric power house to the winch house might be interrupted, if dependence were placed on the single system of service. In order to guard against this it has been realised that even should the supply of the whole town break down it must be regarded as an essential condition that the transporter should be kept running. For this reason there is an emergency power supply to the winch house direct from the Corporation power house battery which gives a direct continuous current supply for emergency service. Under normal conditions, however, a duplicate cable is laid which gives a supply from one of the sub-stations transforming alternating current at 11,000 volts to three-wire 450 continuous current, and it is upon this system that the running of the transporter usually depends.

It will be readily imagined that this extensive and somewhat unique piece of engineering has occupied the attention of several responsible parties; the consulting engineers to the Middlesbrough Corporation were the Cleveland Bridge and Engineering Company, Ltd., of Darlington, and the contractors were Sir William Arrol & Company, Ltd., of Glasgow. The work of the bridge construction was carried on under the supervision of Mr. S. E. Burgess, M.I.C.E., the Borough Engineer of Middlesbrough, to whom we are indebted for some part of the above information, while the British Westinghouse Company was responsible for the electrical equipment, and the whole of the electrical work was carried out to the instructions and under the supervision of Mr. H. M. Taylor, Borough Electrical Engineer of Middlesbrough. Its unique design and satisfactory operation reflects considerable credit on those who have been associated with the development of this bridge, and the operation affords an illustration of the uses to which electricity can be profitably applied.

Correspondence.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

A WIRING RULE.

To the Editor of the Electrical Engineer.

Sir,—The wires of the various circuits emanating from any 2-pole distribution board of three sorts:—

(a) + Wires.—Wires in permanent connection with the positive bus-bar (or what is assumed to be the positive bar in a.c. work);

(b) — Wires.—Wires in permanent connection with the negative bus-bar (or what is assumed to be the negative bar in a.c. work);

(c) Connecting Wires.—All wires other than above, viz., those running from switches to lamps and other consuming devices.

My proposition is that wires with three instead of two easily-distinguished outer coverings would be advantageous in wiring work. Leads (+ wires) and returns (— wires) should have a brownish and black colour, respectively, as at present; while connecting wires should be of some other colour, or preferably a braided or other mixture of two colours.

The object in view is to facilitate work, and any subsequent additions or alterations thereto; and it is hardly necessary to prove that this object would be attained.

The rule can also be extended to wiring diagrams, where red (or thin black) lines would represent positive wires, black (or thick black) lines would represent negative wires, and dotted lines would represent connecting wires.

The above is an adaptation of a rule I gave for bell and kindred wiring some years ago, and I have often thought of suggesting its adoption for lighting and similar circuits.

If some firm of cable makers were to signify their willingness to supply the necessary distinguishing covering for the usual small sizes of connecting wires, I think, from what I have heard, that a number of contractors would be inclined to put the rule into practice.

Yours, etc.,

West Norwood, S.E. W. Perren Maycock.

The Swedish Government has begun a new power installation which bids fair to rival even the vast Trollhattan works. It will utilise the ample water power of the Lule, which falls into the Gulf of Bothnia at Lulea. The minimum power available is 70,000 h.p., and by means of reservoirs a turbine h.p. of 300,000 can be made available at any season of the year.

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AUXILIARY MACHINERY FOR INTERNAL COMBUSTION ENGINED VESSELS.

Before the members of the Institute of Marine Engineers, London, Mr. W. R. Cummins (Member) read a paper on the above very important question, which raised considerable interest.

Mr. CUMMINS pointed out that during the past year several important developments in marine oil engines had taken place. All the larger and more important work has been designed by our competitors on the other side of the German Ocean. British firms appear to be sitting on the fence, to see how these experiments will turn out.

The auxiliary machinery on board modern vessels is of such varied character and has to fulfil so many different conditions that the problem of applying suitable motive power is of some difficulty. It is, of course, desirable, if not necessary, that the same type of motive power should be used throughout the ship.

The case of steam, with its great flexibility, very few difficulties were met, but in the case of internal combustion engined ships some difficulty arose, as it would be necessary to have steam boilers on board. He went into details of various methods, mechanical, hydraulic, compressed air, and electrical driving for such.

Various lantern slides were shown, describing the different type of electrical steering gear that had been from time to time proposed and in some cases applied to actual ships.

One of the difficulties met with when applying an electric motor to the steering gear was, if a steam engine of a steam steering gear were to get out of control and put the rudder up against the stops, or if a heavy sea struck the rudder, the engine would just pull up, and no damage would be done, and the engine would start up again when the excessive load was removed. In the matter of the electric motor, if it were pulled up dead it would burn out if no overload cutout were provided. He, on the whole, thought that the compressed air system would be best for the purpose.

The CHAIRMAN (Mr. F. M. TIMPSON), in opening the discussion, stated that compressed air had been used for auxiliaries on the oil-engined vessel "Vulcanus," but the owners had reverted to the use of steam with oil-fired furnaces in later boats.

Mr. WILLIAM P. DURTNALL (Member) said that many attempts had been made to utilise compressed air for the various purposes, but the compression and other losses were such as to make the over-all efficiency very unfavourable, as compared with steam, and even when used with internal combustion engines driving the compressors. Hydraulic gear was more efficient of the two, but either could not attempt to compete with electrical driving for the purposes required. Recently he had tested a 7,000-ton cargo vessel at Venice, whilst she was unloading her cargo, and had piped the winches back to the engine room, and returned the water through a condenser, and weighed same: this in order to ascertain the evaporative efficiency of the boilers. This was found to be approximately 9 lbs. of water evaporated per lb. of coal burnt, which was a reasonable result under the circumstances, but, on weighing the coal burnt over three days' working, it was evident that as much as 29·2 lbs. of coal was burnt per ton of cargo discharged, which was an enormous consumption for the work done, and most of the consumption represented losses through radiation and pipe friction, etc.

The owners had since decided to instal the "Paragon" Variable Voltage System of electrical transmission for this ship, and after describing in some detail this interesting method of driving and demonstrating that a great advantage in the matter of fuel economy will be demonstrated by its use by the fact that a high load factor can be kept on the prime-mover in the engine room, and, further, that the kinetic energy of the falling weight and the mass of the motor and the winch would be recuperated in the form of electrical energy, which would be sent back to the mains and which could be used by other work about the ship, as no resistance were used in connection with this system for starting, and speed regulation, and further as the steering gear motor could stand, if desired, with the full current on at low voltage. Thus the conditions of the steam engine would be met, and also a very vast reduction in the fuel consumption per ton of cargo discharged would take place. He further stated that "anything" that could be done by means of steam could by proper design be satisfactorily carried out by electric motors and with greater fuel economy, because of the higher thermal efficiency that can be obtained by quick running engines as prime-movers as compared with slow working direct-coupled pumps, fans, etc., driven by steam or compressed air.

Mr. W. MCLAREN (Member) considered that the deck machinery, such as winches, windlasses, and capstan, should be driven by electrical gear, especially as the hydraulic gear cost just as much to lift one hundredweight as to lift, say, three tons on a three-ton winch or crane. He, however, thought that either hydraulic or compressed air could be used with advantage on the steering gear.

The meeting was adjourned for a further discussion on the subject at a later date.

As will be seen from an official notice printed elsewhere, a Charge Engineer is wanted at the Newport (Mon.) Corporation Electricity Works.

LONDON ELECTRICAL ENGINEERS.—Officer commanding, Lieut.-Colonel H. M. Leaf. The following orders have been issued for the current week:—Monday, January 29—"A" Company: Lecture on Military Telephones, 8 to 9 p.m.: technical work, musketry instruction (standard tests), 9 to 10 p.m. Tuesday, January 30—"B" Company: Lecture on Military Telephones, 8 to 9 p.m.; technical work, musketry instruction (standard tests), 9 to 10 p.m. Thursday, February 1—"C" Company: Lecture on Military Telephones, 8 to 9 p.m.; technical work, musketry instructions (standard tests), 9 to 10 p.m. Friday, February 2—"D" Company: Lecture on Military Telephones, 8 to 9 p.m.; technical work, musketry instruction (standard tests), 9 to 10 p.m. Saturday, February 3—Headquarters will be opened for regimental business from 10 a.m. to 12 noon.—(Signed) P. H. Campbell, Captain R. E. and Adjutant for O.C., London Electrical Engineers.

STANDARD ELECTRICAL WORKS.

VECTORS AND VECTOR DIAGRAMS: Applied to the Alternating Current Circuit. With examples of their use in the Theory of Transformers, and of Single and Polyphase Motors, etc. By William Cramp, M.I.E.E., Consulting Engineer, and Special Lecturer in Electrical Design in the University of Manchester, and Charles F. Smith, M.I.E.E., Assoc.M.Inst.C.E., Whit. Schol., Lecturer in Electrical Engineering, the University of Manchester, and Director of the Electrical Engineering Laboratories, Municipal School of Technology, Manchester. With 114 diagrams. 8vo. 7s. 6d. net. (0153)

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ELECTRIC SMELTING AND REFINING. By Dr. W. Borchers. Translated by W. G. McMillan, F.I.C., F.C.S. Second Edition, revised. Post free. 22s. (329).

ELECTRIC FURNACES: The Production of Heat from Electrical Energy and the Construction of Electric Furnaces. By Wilhelm Borchers, Privy Councillor, Doctor of Philosophy, Professor of Metallurgy and Director of the Institute of Mines and Electro-Metallurgy at the Royal Technical College, Aachen. Translated by Henry G. Solomon, A.M.I.E.E., Consulting Electrical Engineer. With illustrations. 8vo. 7s. 6d. net. (0156)

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ASSOCIATION OF CONSULTING ENGINEERS.

We have received the following official report of the recent meeting of this Association :—

On Monday, the 15th inst., the inaugural meeting of the above Association took place for the purpose of formally receiving the rules which had been drawn up by the committee appointed for this purpose at the opening meeting some 18 months ago. Between 60 and 70 engineers were present. The chair was taken by Mr. James Swinburne, who was supported by the majority of the committee, which consists of the following engineers :—John S. Alford, H. Percy Boulnois, Edward M. Eaton, Robert Hammond, Joseph H. Harrison, Baldwin Latham, Charles Lomax, Sidney R. Lowcock, Ernest L. Mansergh, Arthur J. Martin, Thomas L. Miller, William M. Mordey, William H. Patchell, W. Llewellyn Preece, Henry Rofe, John F. C. Snell, E. Herbert Stevenson, James Swinburne, A. A. Campbell Swinton, Gotfred Midgley Taylor and Alfred H. Dykes, honorary secretary.

The Chairman, in opening the proceedings, said that it was his first business to explain the objects of the Association, but that he did not think he need say very much in that direction, because they all knew what the objects were. The Association should have been launched 50 years ago ; in the present state of things, however, it was very difficult to form an Association in such a way as to be satisfactory to everybody. At the same time he was of opinion that if consulting engineers did not take this opportunity of uniting themselves together there was no chance of their ever doing so. It behoved them, therefore, to proceed very carefully and to build on sure foundations.

Most institutions had begun by taking in everyone they could get, with the idea that the more members they got the more powerful the institution would be, and the result was that after they had been in existence some time they had to narrow down. He thought that they should, in the present case, go to the other extreme. If they began by making it very small, perhaps in the opinion of many, too small, then, when the Association was in active existence, it could always enlarge itself in any direction it desired, should it be thought advisable.

One of the qualifications for membership in the rules was that the applicant should be a full member of the institution controlling the branch of engineering in which he practised. It was true that the rules provided that, in addition, members should be of such standing as, in the opinion of the committee of the Association, entitled them to admission to the Association ; but in the initial stage in which they were at the moment (namely, of having formed the Association and appointed the committee, drawn up rules and received applications for membership, but not having yet actually any members), the committee were of opinion that it would be wise to adopt some recognised standard of qualifications and to limit the first members to those possessing the qualification of corporate membership of the Institution of Civil Engineers.

They were aware that this restriction might be criticised by some people, who might say that they were mechanical engineers or electrical engineers, and of eminence in their profession, and did not see why the fact that they had not joined the Institution of Civil Engineers should prevent them from joining the Association. On the other hand, it must not be overlooked that the Institution of Civil Engineers was not only the oldest institution, but was the parent engineering institution, and that the majority of consulting engineers already belonged to it in addition to the institutions representing the particular branch in which they practised.

If any competent consulting engineer, who was not a member of the Civils, felt aggrieved that he could not belong to the Association, surely it was not asking a very great deal of him to ask him to join the Civils. If the Association, starting as a young society, could use a body like the Institution of Civil Engineers, which had always been fairly strict in the selection of its candidates and was getting stricter every year, and thus throw the responsibility of deciding as to a candidate's qualifications upon an established institution, leaving the Association merely to decide as to his qualifications in other respects, they were solving one of the greatest difficulties.

Later on, when the committee would be in a position to know the feeling of consulting engineers in general, and when the members had had time to become acquainted with the working of the Association, they might find it advisable to make some change, but that was a matter for the future. At any rate, the present committee felt strongly that the lines he had indicated should be followed for the moment ; he himself believed that they were the right lines, and probably the permanent lines.

There was another direction in which they thought the committee ought to be very narrow, which was also a matter of considerable difficulty, and that was with regard to the admission to the Association of engineers, many of whom were of the highest eminence, who were receiving a salary and were giving practically the whole of their time to some corporation or some public body. The committee wished to be logical in carrying out their idea of starting on the narrowest lines, and felt that they should confine the Association initially to those regularly in practice as consulting engineers and having their own separate office and staff.

The Association did not aim at stopping competent consulting engineers who might not join them from doing consulting work, nor did they wish to claim a monopoly. The committee felt, however, that engineers falling within the class he had outlined were entitled to associate themselves together and to form an Association which would gradually, through its own standing and character, become recognised as *the* body of consulting engineers.

After the proposed rules had been introduced by Mr. Midgley Taylor and Mr. S. R. Lowcock, a general discussion took place, the speakers being Messrs. B. M. Jenkin, W. Fairley, A. Williams, A. G. Hansard, Cawley, Robert Hammond, E. J. Silcock, H. P. Boulnois, A. S. E. Ackermann, H. P. Raikes, F. W. Hodson, Moss Flower, Druitt Halpin and P. Griffiths. The main points to which speakers referred were the scope of the Association, the desirablity or otherwise of the membership being restricted to corporate members of the Institution of Civil Engineers, registration of consulting engineers, solicitation of work and the desirability of consulting engineers being free from trading or manufacturing interests. In the course of the discussion the Chairman pointed out that the rules were put forward subject to legal revision.

In conclusion, at the suggestion of Mr. Lomax and Mr. W. Duddell, the Chairman put a motion to the meeting to the effect that corporate membership of the Institution of Civil Engineers be a condition of membership of the Association* (with discretionary power to the committee) and that the committee have power to elect members from among those who have applied. This motion having been duly carried, the proceedings terminated with a vote of thanks to the Chairman. It is hoped that all consulting engineers possessing the necessary qualifications will join the Association and communicate at once with Mr. A. H. Dykes, the honorary secretary, at 11, Victoria-street, Westminster, S.W. This will enable a list of first members to be made without delay. A meeting of members will then be called to ratify the Rules and to appoint the Executive Committee.

Mr. Charles James O'Dowd, traffic manager of the Darlington Corporation Tramways, who died recently, in his fifty-ninth year, was a notable figure in the tramway world, having been connected with the system since its inception. Born at Liverpool, in his youth he became a conductor on the first tramways laid down in England, those of Birkenhead, engineered by Mr. George Francis Train, who was also the creator of the Darlington horse tramway system. Mr. O'Dowd also drove the first tramcar in Dublin, in 1872, and was later appointed an inspector at that place. He subsequently drove the first street car at Leicester. He removed to Stockton in 1886, and in the first stages of the electrification of the Stockton, Thornaby, and Middlesbrough system he was appointed divisional superintendent at Norton. Some eight years ago, on the installation of the electric system at Darlington, Mr. O'Dowd was appointed traffic manager.

* Rule 4 (c) now reads as follows :—"He shall be a full member of the Institution representing the particular branch of the profession in which he practises and a corporate member of the Institution of Civil Engineers.

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The Tramways and Electricity Committee of the Belfast Corporation are prepared to receive tenders for the supply of:

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Specifications, with Form of Contract, may be obtained from Mr. T. W. Bloxam, City Electrical Engineer, East Bridge-street, Belfast, on deposit of one guinea for each specification. This deposit will be refunded, provided a bona-fide Tender has been sent in, and not withdrawn.

Extra copies may be obtained at 10s. each, which sum will not be returnable.

Sealed Tenders, endorsed "Tender for Coal Weighing Machine, Electricity Department," or "Tender for Overhead Equipment Material, Electricity Department," to be lodged in my office, not later than 10 a.m. on Monday, February 12, 1912.

The lowest or any Tender not necessarily accepted.

A Tender if sent by post must be registered; if delivered an official receipt must be obtained for it; otherwise the undersigned will not be responsible.

R. MEYER, Town Clerk.

BRISTOL DOCKS.

CABLES AND SWITCHBOARDS AND ELECTRIC LIGHTING, AVONMOUTH.

The Docks Committee of the Council of the City and County of Bristol are prepared to receive tenders for the supply and delivery, construction, testing and maintenance for 12 months after they shall have been taken into public use, of Cables, Switchboards, and Electric Arc and Incandescent Lighting at the Avonmouth Docks.

On and after Monday, January 29, 1912, copies of the Specification, Schedule, Form of Tender and Form of Contract and copies of the contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the Secretary of the Docks Committee, Docks Office, 19, Queen-square, Bristol, to whom all cheques must be made payable. The deposit of £5 will be returned to bona fide tenderers after receipt of a tender, accompanied by all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope endorsed "Tender for Cables and Lighting, West Wall and Cold Stores," and addressed to the Secretary of the Docks Committee, Docks Office, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Monday, the 19th day of February, 1912.

The Docks Committee of the Council of the City and County of Bristol do not bind themselves to accept the lowest or any Tender.

W. W. SQUIRE, Engineer.

Engineer's Office, Cumberland-road,
Bristol.
January 23, 1912.

APPOINTMENTS.

WANTED, a Charge Engineer for Newport Corporation Electricity Works. Applicants must have had thorough experience with H.T. single-phase and D.C. work; preference will be given to those having also had E.H.T. three-phase experience. Salary £2 per week, rising to £2 10s. None but fully qualified Central Station Engineers need apply. Applications, stating experience and age, also earliest date able to start duty must be sent to

H. COLLINGS BISHOP, M.I.E.E.,
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BELFAST.—The Tramways and Electricity Department of the City and County Borough invite tenders for one automatic Coal Weighing Machine and Overhead Electrical Equipment Material. Particulars (£1 1s. each, returnable) from Mr. T. W. Bloxan, City Electrical Engineer, East Bridge-street. February 12. See Official Notice.

BRISTOL.—The Docks Committee of the City Council invite tenders for the supply and delivery, testing and maintenance for 12 months after they shall have been taken into public use, of Cables, Switchboards and Electric Arc and Incandescent Lighting at the Avonmouth Docks. Particulars (£5, returnable) from the Secretary of the Docks Committee, 19, Queen-square. February 19. See Official Notice.

BURTON-ON-TRENT.—The Corporation invites tenders for the supply and erection of the following plant, etc., for the Electricity Department:—Specification No. (12) one 1,950 kw. turbo-alternator and condenser; (13) switchboard and gallery; (14) one 500 kw. motor-generator, one 300 kw. motor-generator; (15) water-tube boiler, stoker and superheater; (16) superheaters; (17) steel stack; (18) economisers; (19) mains. Particulars (£1) from Mr. Thos. Hall, Borough Electrical Engineer. Guild-street. January 27.

CROYDON.—The Corporation invite tenders for the supply of a mixed pressure turbine plant at the electricity works, Factory-lane. Particulars (£1 1s.) from the Borough Electrical Engineer. January 29.

DUBLIN.—The Port and Docks Board invite tenders for the supply of two 4-ton electric Portal wharf cranes. Particulars (£1) from Sir J. P. Griffith, M.Inst.C.E, East Water, Dublin. January 30.

EXETER.—The Visiting Committee of the Asylum invite tenders for the supply of (a) steel conduits and fittings; (b) vulcanised rubber cables; (c) distribution fuse boards, distribution switch and fuse boards. Particulars from the Clerk, 8, Southernhay West, Exeter. February 2.

HORNSEY.—The Town Council invite tenders for the supply of (a) Electricity Meters, (b) Cables, Cable Stores, etc., for the Electricity Works. Particulars (10s. 6d., returnable) from the Borough Electrical Engineer, Tottenham-lane. February 7.

KENDAL.—The Corporation invite tenders for the supply of one 100 kw. direct-current steam generating set. Particulars from Mr. J. A. T. Barnes, Borough Electrical Engineer. February 1.

LEEDS.—The Corporation invite tenders for the supply of 1,000 alternating current watt meters, to be delivered as required on or before June 30, 1913. Particulars from Mr. H. Dickenson, Manager, Electric Lighting Department, 1, Whitehall-road. February 14.

LONDON.—The London County Council invite tenders for an electrical installation at their School of Photo-Engraving and Lithography, comprising 280 lighting and 50 power points. Particulars (£1, returnable) from Mr. M. Fitzmaurice, C.M.G., County Hall, Spring-gardens, S.W. January 30.

OSRAM-LAMPS

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MANCHESTER.—The Tramways Committee of the City Corporation invite tenders for the supply of tramcar-type ampere-hour meters. Particulars from Mr. J. M. McElroy, General Manager, 55, Piccadilly. February 20.

RHYL.—The Urban District Council invite tenders for the supply of 1,700 yards ·1 overhead feeder cable. Particulars from Mr. E. H. Wright, Electricity Works. January 31.

SHOREDITCH.—The Borough Council invite tenders for converting to electric motor drive the existing steam action of the deep well pump at Hoxton Public Baths. Particulars from the Superintendent and Engineer, Hoxton Baths, Pitfield-street, N. January 30.

TUNBRIDGE WELLS.—The Corporation invite tenders for the supply and erection of switchgear. Particulars from Mr. J. N. Beauchamp, Borough Electrical Engineer, Stanley-road.

STEPNEY.—The Borough Council invites tenders for the supply and erection complete of one e.h.t. converting plant, suitable for 6,000 volt three-phase a.c. to l.t.d.c., together with e.h.t. and l.t. switch-gear, etc. Particulars from Mr. W. C. P. Tapper, A.M.I.E.E., borough electrical engineer and manager, No. 27, Osborn-street, Whitechapel, E., upon receipt of a deposit of five guineas (returnable). January 29.

OVERSEAS.

CONSTANTINOPLE.—Tenders will be received at the "Ministère des Travaux Publics," Constantinople, up to February 20, for a concession for the supply of electric light and power to the town of Adalia, which has a population of some 30,000. The supply of power for telegraph and telephone installations and electric traction is excluded from the concession. Power is to be generated from waterfalls. Tenderers must supply proof of technical and financial competency, and a deposit of £T250 (£225) is required with each tender. Local representation is practically indispensable in the case of Turkish Government contracts. A list of British commission agents established in Constantinople may be obtained by British firms on application to the Commercial Intelligence Branch of the Board of Trade.

NAPIER, N.Z.—Tenders are invited by the Corporation of Napier, New Zealand, for electric tramway, lighting and power works as follows:—Contract No. 2.—Permanent way, road and sewer alterations, overhead work and supply mains. Contract No. 3.—Power station, car shed, and repair shop equipments. Contract No. 4.—Rolling stock. Tenders will be received by the Town Clerk, Napier, up to March 7. A deposit of 2½% of the value of the offer must accompany each tender. Copies of the plans and specifications may be seen by British contractors at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

ITALY.—The "Gazzetta Ufficiale" notifies that tenders will be received, up to February 17, at the office of the "Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Piazza Municipio 37," Naples, for the supply and erection of machinery and apparatus, as well as hydraulic, electric and general accessories required in connection with the central electric generating station in Naples. The upset price is put at 1,230,000 lire (£49,200) and a deposit of 25,000 lire (£1,000) will be required to qualify any tender. Twenty months are allowed for the supply of the material. The energy to be generated at the Volturno Springs and carried into Naples will amount to 12,000 kw. a., and the plant must have a capacity for the production of a further 12,000 kw. a., if required. This contract is open to foreign competition, but all documents appertaining thereto must be made out in Italian. Plans and specifications governing the contract may be seen at the above-mentioned office in Naples.

MOROCCO.—The British Consul-General at Tangier (Mr. H. E. White, C.M.G.) reports that the Moroccan Adjudications Commission intend to make a contract, by private arrangement after competition, for the supply and delivery of two steam engines and of electric lighting plant, for an engineering workshop to be established at Tangier for the repair of lighters, etc. Applications from firms desirous of tendering will be received by "M. le Président de la Commission Générale des Adjudications et des Marchés, Dar En Niaba," Tangier, up to February 5. A copy of the general regulations (in French) may be seen by British manufacturers at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

PORTUGAL.—Tenders, made out in Portuguese, will be received up to March 2, at the offices of the "Conselho de Administraçao do Porto de Lisboa," Lisbon, for the supply of 10 electric cranes, in accordance with the specifications which may be seen at the above-mentioned offices. A deposit of 1,500 milreis (about £300) will be required to qualify any tender, which amount must be increased by the successful tenderer to 7% of the accepted price. Each of the 10 cranes must have a lifting capacity of 1,500 kilogs., but four of them must also be capable of lifting material up to 3,000 kilogs. in weight. Competitors other than Portuguese must enclose with their tender documents viséd and registered at a Portuguese Legation or Consulate testifying their willingness to abide by the Portuguese law should any dispute arise in connection with the contract.

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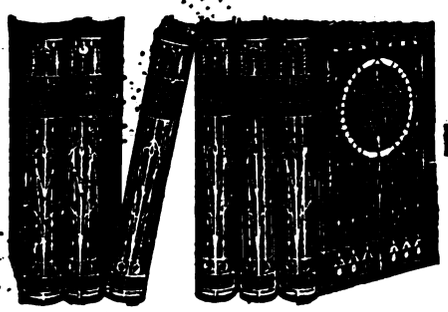

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Electrical Company Notes.

The directors of the London Electric Railway Company (Underground) have decided to recommend the payment of dividend on the four per cent. preference stock for the six months to December 31 at the rate of £4 per cent. per annum. The directors have also decided to recommend the payment of a dividend on the ordinary shares of the company for the past six months at the rate of 1 per cent. per annum. The sum of £2,400 is to be carried forward, and £7,500 has been reserved for renewals. The dividend on the ordinary shares a year ago was at the rate of ¾ per cent., when the carry-forward was £3,474.

A prospectus has been issued in connection with the offer by the Electric and General Investment Company, Ltd., of £100,000 four-and-a-half per cent guaranteed debenture stock of the Tramways (M.E.T.) Omnibus Company, Ltd., which will arrange a service of one hundred motor omnibuses as feeders to the tramway routes of the Metropolitan Electric Tramways, Ltd.

The directors of the Electric Construction Company, Ltd., have declared an interim dividend at the rate of 7 per cent. per annum on the preference shares for the half-year to November 30.

The British Columbia Electric Railway Company, Ltd., announces a dividend at the rate of 5 per cent., per annum, on the 5 per cent. non-cumulative preferred ordinary stock for the half-year ended December 31, 1911, together with an additional dividend at the rate of 1 per cent. per annum for the same period. The present quotation for this stock is 120-124, whilst the deferred ordinary stock stands at 137-142—a very wide margin it must be admitted.

The directors of the Urban Electric Supply Company, Ltd., have drawn up a scheme of capital reorganisation under which they recommend the reduction of the par value of the 80,000 ordinary shares from £5 to £3 by writing off £2 per share. The dividend of the preference shareholders until the end of 1913 will be paid partly in cash and partly by means of funded certificates. It will not be possible to pay more than 2 per cent. in cash on the preference capital for 1911; to be followed by 3 per cent. for 1912 and by 4 per cent. for 1913.

Cullingham & Freeman,
12, Crane Court, Fleet Street, E.C.
CATALOGUE ILLUSTRATORS
TECHNICAL PHOTOGRAPHERS
ENGRAVERS BY ALL PROCESSES
SEND FOR PRICES

VULCANITE
ALL SPECIAL ARTICLES QUOTED FOR ON RECEIPT OF SAMPLE, SKETCH, OR SPECIFICATION.
F. CARSON & EVANS.
3A Fenchurch Buildings, LONDON, E.C.
EBONITE

BLAKE & INSULATING STAPLES
Write for Samples and Prices.
MOSSES & MITCHELL,
Chiswell Works, 122-124, GOLDEN LANE, E.C.

The accounts of the Liverpool Overhead Railway Company for the half-year ended December 31 last, show an available balance of £13,439 4s., and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares, and 2 per cent. per annum on the ordinary shares, which, with the 1 per cent. paid for the half-year ended June 30 last, makes 1½ per cent. for the year, against ¾ per cent. for last year. The balance of £4,763 7s. will be carried forward to next half-year.

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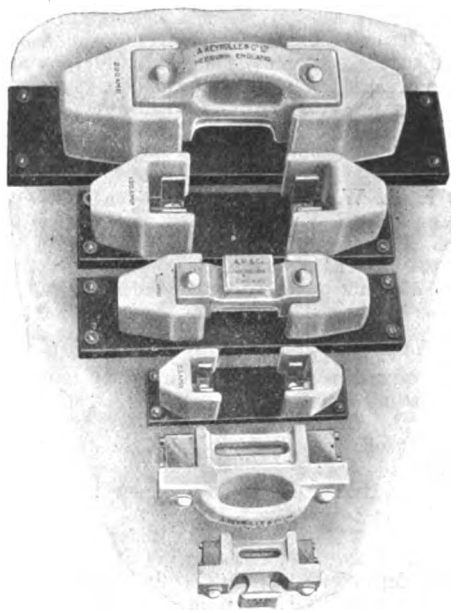
PUBLICITY SECTION.

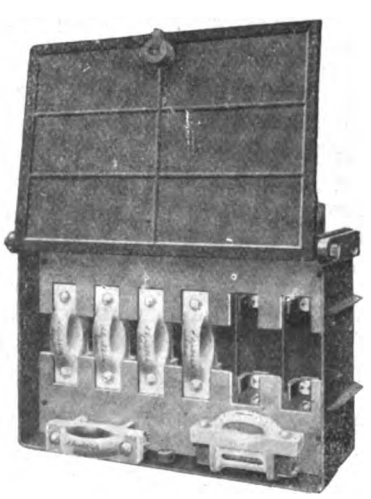
Notes on Novelties, Trade Specialities, New Catalogues and Lists, &c.

Reyrolle Fuse Handles.

We illustrate a line of fuse handles which Messrs. A. Reyrolle & Company, Ltd., Hebburn-on-Tyne, have had on the market for some little time, and for which the demand is so great that at times they have difficulty in keeping up with the demand. The fuse handles are of the "grip" type, and the fuse wire is carried through an asbestos tube, which is large enough to allow of a circulation of air, and the outside of which is cooled by the air entering the slots, shown on the illustration. Another important feature of this fuse is the patent system of



mounting the contact blocks on the porcelains, in such a way that those have an universal motion, and this, of course, obviates the necessity of very accurate setting of the fuse clips, and there is an additional advantage in that the area of contact between the metal fuse block and the porcelain is exceedingly small, with the result that a minimum heat is transferred to the porcelain. These fuses are made in all sizes from 25 amperes up to 600 amperes, and suitable for circuits up to 600 volts. Figure No. 2 illustrates one of a line of fuse distribution boxes fitted with these fuse handles, and also with a protecting



screen to obviate accidental contact with the clips. Messrs. A. Reyrolle & Company recommend copper fuse wire for use with these handles, as this is found to be perfectly satisfactory with their type of fuse box in which there is nothing of a combustible nature. It is sometimes urged against copper fuse wire that the wire oxidises rapidly in the presence of moist air, but Messrs. A. Reyrolle & Company have not found that this action is rapid enough to cause any inconvenience, and the fact that these fuses are being used in large numbers on the North-East Coast, where the climatic conditions are anything but ideal, is a clear indication that there is not much in the common belief that copper wire is unsatisfactory for fuses.

"Leuconium" English-made Lamps.

The Stearn Electric Lamp Company, Ltd., of 47, Victoria-street, Westminster, have succeeded in achieving what has hitherto been regarded as the impossible namely, a nine candle-power 200 volt 15 watt and a 4·5 candle-power 100 volt 8 watt metal filament lamp. These are English-made "Leuconium" lamps and may be taken to represent the most recent and in many respects the most remarkable development in metal lamp manufacture. These new lamps have now gone far beyond the experimental stage, and are being made daily by the Stearn Lamp Company, at whose offices there is already a moderate number in stock to supply immediate orders. This stock also includes 200 to 250 volt 20 watt "Leuconium" lamps of 12·5 c.p. and 100 to 125 volt 10 watt lamps of 6 c.p. High voltage lamps are listed at 3s. 3d., and low voltage at 2s. 9d., less the usual trade discounts We have tested one of the high voltage lamps with perfectly satisfactory results.

Diary.

FRIDAY, JANUARY 26.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Paper, "The Knight Sleeve-valve Engine," Mr. J. O. Ruscoe. Chairman, Mr. E. B. Ware.

BATTERSEA POLYTECHNIC.—Battersea Park-road. "Shades and Reflectors," by Mr. J. S. Dow, 7.30 p.m.

SATURDAY, JANUARY 27.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Local Section).—Meeting with the Manchester Association of Engineers. Paper, "Electrical Furnaces," Mr. Cecil Myers.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—St. Bride Institute, E.C. "Application of Superheated Steam to Locomotives," by Mr. H. P. Bray, 4.45 p.m.

WEDNESDAY, JANUARY 31.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi. "Recent Progress in Radio-Telegraphy," by Prof. G. W. Osborn Howe, 8 p.m.

FRIDAY, FEBRUARY 2.

BATTERSEA POLYTECHNIC.—Battersea Park-road. "Daylight and Artificial Lighting Compared," by Mr. J. S. Dow, 7.30 p.m.

SATURDAY, FEBRUARY 3.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—Annual Dance, Caxton Wall, Westminster.

FRIDAY, FEBRUARY 9.

BATTERSEA POLYTECHNIC.—Battersea Park-road. "Colour of Artificial Illuminants," by Mr. J. S. Dow, 7.30 p.m.

FRIDAY, FEBRUARY 16.

BATTERSEA POLYTECHNIC.—Battersea Park-road. "Practical Lighting Problems," by Mr. J. S. Dow, 7.30 p.m.

The Benjamin Electric, Ltd., have registered "Luxogen" as their telegraphic address for their offices and showrooms at 117, Victoria-street, Westminster.

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Weekly Digest of Electrical Patents.

Specially compiled for "Electrical Engineer."

Electric Current Generators.

26187—1910. Dr. M. Breslauer, Berlin, Hoppe garten. This generator, which is designed to generate an alternating current the two alternations of which are unequal, comprises in combination with induction coils, a rotable magnet in which two pole tips of opposite polarity and very near to one another and have a small air gap between the stator and rotor, whereas the opposite pair of tips are more remote from one another and have a greater air gap between the stator and the rotor, the air gap being tapered gradually from the small width to the larger so as to secure a gradual decrease and an equally gradual increase of the magnetism in the induction coil up to the maximum, so that the charge from one maximum to the other is as rapid as possible.

Current Controlling Devices.

26248—1910. W. K. L. Dickeon, 4, Denman-street, Piccadilly Circus. This switch for controlling electric signs comprises a motor which rotates a spindle on which cams are arranged in relation to sets of flexible blades electrically connected to electric lamps. As the spindle rotates the cams press upon and are removed from the blades so as to consecutively open and close the electric circuits.

Mercury Contact Breakers.

26341—1910. Reineger, Gebbert & Schall, A.G. 27, Luitpold Strasse, Erlangen, Bavaria. The contact is closed by a bell or chamber which is closed at the bottom of the mercury and prevents the gas or vapour which is generated from expanding upwards so that the pressure of gas and vapour is caused to act downwards on the surface of the mercury.

Controlling Speed of Electric Motors.

26439—1910. Cutler-Hammer, Manufacturing Company, Milwaukee, U.S.A. A speed controlling element is connected to the movable plunger or core of the operating solenoid through the intervention of a member which causes the controlling element to be set in different positions so as to be brought to rest in any predetermined positions to cause the motor to operate at any predetermined speed.

Electric Batteries for Train Lighting.

26542—1910. E. J. Clark, Cla Jen, Whipp's Cross-road, Leytonstone. This secondary battery has side plates, which support the set of electrodes of one sign while the electrodes of the other sign, contact with the side plates at a different level so that there is no supporting ledge extending from one plate to another of the same or a different polarity, and thus the building up of deposit between the neighbouring plates is obviated.

Automatic Electric Regulators.

5499—1911. U.S.A. Light & Heating Company, 30, Church-street, New York. This regulator comprises a variable pressure rheostat and a relay device for normally short circuiting the controlling winding but adapted to vibrate to introduce the winding rapidly into circuit for regulating purposes.

Interruptor for Electric Ignition.

180—1911. R. Bosch, Hoppenlaustrassell, Stuttgart. This interruptor is fitted with an intermediate member adapted to transmit the radical deviation which it receives from one or more cams to the movable electrode in an axial direction.

Obtaining Alternating Currents from Continuous Current.

26390—1910. A. M. Taylor, Ashfield-road, Kings Heath. This current transformer has a special coil for excitation purpose supplied from a small synchronous alternator driven from the same spindle, which drives the brushes of the main commutator. The coil saturates the core of the main transformer magnetically, and induces an E. M. F. in the primary, and secondary coils having a voltage approaching zero for some distance on either side of the point of short circuit of the primary coil by the commutator. This reduces the E.M.F. generated in the primary coil and also the current when under short circuit, and so avoids sparking at the commutator.

Dynamos.

26393—1910. E. F. Freeman, Norham Place, Newcastle. The dynamo field has two sets of windings so that all the poles at one end of the field are north and the poles at the other end are south.

Electric Regulators.

27037—1910. H. Leitner, Woking. Regulation is effected automatically by utilising the potential differences of the resistances progressively inserted in the lamp circuit and the potential difference of the resistance inserted in the dynamo field circuit.

Electrodes for Arc Lamps.

14729—1911. P. Conradiby, 9, Spittlertorgrabren, Nuremberg. The electrodes have spiral grooves fitted with a suitable mass so that the arc is caused to follow a circle around the electrode.

Cooling Dynamos.

25036—1910. G. F. Fawcus, Altrincham Electric Supply Ltd., Altrincham. Thermometric devices are provided which control the volume supply of cooling liquid to the cooling channels of generators or motors. The temperature of the generator or motor affects the operation of the thermometric devices.

Self-Regulating Dynamo Electric Machines.

25588—1910. C. A. Vandervelt & A. H. Midgley, Warple Way, Acton Vale. These machines are provided with ordinary and supplementary poles, brushes and magnet coils. The connections are so arranged that certain of the armature conductors situated out of the zone of magnetic influence of the suplementary poles are individually short-circuited by the brushes and the current flowing in a certain portion of the armature conductors only is utilised to demagnetise the magnetic field of the ordinary poles to secure self-regulation with sparkless commutation.

Periodicity Indicators.

5998—1911. L. W. Wild, York Mansion, York-street, Westminster. The indicator is fitted with a vane of magnetic metal. The vane moves between the poles of two electromagnets. The electric circuits are so arranged that the ratio of the currents which energises the magnet depends upon the periodicity of the source of the supply.

Producing Disc-Like Electric Flaming Arcs.

13335—1911. Elektrochemische Werke, G.m.b.H. Berlin. This production of disc-like flames for carrying out gas reactions is effected by the gases, which are caused to move in a spiral path on both sides of the arc so that the central plane of the layer of the spiral path lies parallel to the flame disc formed by this movement of gas without crossing the arcs and without considerable renewal of the gas taking place in the flame gone.

Arc Lamp Electrodes.

17723—1911. General Electric Company, Schenectady, U.S.A. In order to produce a flaming or luminous arc a light-giving material is introduced into the arc from another electrode. The light giving electrode contains titanium carbide and the steadying elecrode contains potassium biborate.

Insulating Sleeve for Electrical Transformers.

20523—1911. E. Haefely, 29, Bundersstrasse, Basle. This sleeve is on polygonal cross section. Between the angles of the sleeve and the circumference of an inscribed circle and between the sides of the sleeve and the circumference of a circumscribed circle spandrels are produced which are displaced in relation to each other to the extent of half of the length of one side of the polygon. When the sleeve is in position in a transformer the spandrels serve as channels for the circulation of the cooling medium while the sleeve itself affords mechanical support to the windings of the transformer between which it is interposed and maintains them in proper relative position.

MIDLANDS ELECTRICAL ENGINEERS' BALL.

The first Midlands Electrical Engineers' ball was held in the Grand Hotel, Birmingham, on Friday, the 12th instant, when about two hundred guests were present. The suite of rooms set apart for the hosts and their guests had been most charmingly decorated, the entrance hall being quite transformed in appearance by an arrangement of bay trees, palms, and white and pink chrysanthemums, with a miniature fountain cunningly devised out of a block of natural ice, in the base of which gold fish were disporting themselves. Trailed with smilax, with carnations interspersed, and illuminated with electric lamps, the creation called forth many admiring comments. In the Grosvenor Room, where the dancing took place, the electroliers were entwined with smilax and Britannia carnations. Dancing commenced at 8.45 and continued until 2 o'clock, interrupted only by supper, at which the healths of Mr. R. A. Chattock, the City Electrical Engineer and Chairman of the Executive Committee of the ball, and Mrs. Chattock, were drank with enthusiasm. The extraordinary success of this, the first Midlands Electrical Engineers' ball, will encourage the Executive Committee to make it an annual affair.

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CLASSIFIED DIRECTORY.

MANUFACTURERS AND MERCHANTS.

Accumulators.
Essex Accumulator Co., Leytonstone, London, N.E.
Hart Accumulator Co., Marshgate-lane, Stratford.
Johnson & Phillips, Old Charlton, Kent.

Accumulator Acid Manufacturers.
Spencer, Chapman & Messel, 36, Mark-lane, London, E.C.

Acid Proof Paints.
Griffiths Bros., Mack's-road, Bermondsey, S.E.

Ammeters and Voltmeters.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Arc Lamp Hoists.
London Electric Firm, George-st., Croydon.

Auto-Transformers.
British Westinghouse Electrical and Mfg. Co., Manchester.
Johnson & Phillips, Old Charlton, Kent.

Batteries (Primary) and Accessories.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Belting.
Willcox & Co., 36, Southwark-street, S.E.

Boilermakers.
Babcock & Wilcox, 30, Farringdon-st., E.C.

Bolts, Nuts, Washers, Rivets & Screws.
Tetley Bros., Ltd., Floodgate Street, Birmingham.

Cable and Wire-Covering Machinery.
Johnson & Phillips, Old Charlton, Kent.
eld Bros., 25, Rudge Row, Cannon Street.

Carbon Filament Lamps.
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.

Carbons (Arc Light).
General Electric Co., 71, Queen Victoria-street, E.C.
Johnson & Phillips, Old Charlton, Kent.
Mayer, H. G., & Co., 67, Aldersgate-street, London, E.C.
Sloan Electrical Co., Ltd., 15, Fore-street, London, E.C.

Cable and Wire Makers.
Callender's Cable and Construction Co., Hamilton House, Victoria-embank't, E.C.
Feld Bros., 25, Rudge Row, Cannon Street
General Electric Co., 71, Queen Victoria-st, E.C.
Hooper's Telegraph and Indiarubber Works. 31, Lombard-st., E.C., & Millwall Docks.
Johnson & Phillips, Old Charlton, Kent.
London Electric Wire Co., Playhouse-yd., E.C.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Casings and Cleats.
General Electric Co., 71, Queen Victoria-street, E.C.

Chemicals.
Spencer, Chapman & Messel, 36, Mark-lane, London, E.C.

Commutator Grinders.
Phillips Commutator Grinders Co., Ltd., 27, Walbrook, E.C.

Condensing Plant.
Allen, W. H., Son, & Co., Queen's Engineering Works, Bedford.
Belliss & Morcom, Ledsam-street Works, Birmingham.
British Westinghouse Electrical and Mfg. Co., Manchester.
Willans & Robinson, Victoria Works, Rugby.

Conduits.
Flexible Metallic Tubing Co., Ponders End, Middlesex, & 112, Queen Victoria-street.
General Electric Co., 71, Queen Victoria-st
Metallic Seamless Tube Co., Wiggin-street Birmingham.

Coppersmiths.
Andrews, R. W., & Co., 148-150, Pentonville-road, London, N.
Dore, J., & Co., High-st., Bromley-by-Bow.
Harvey, G. A. & Co., Lewsham, London, S.E.

Die-Finished Castings.
Aerators Limited, "Prana" Sparklet Works, Upper Edmonton, London, N.

Distributing Boxes & Wall Plugs.
Reyrolle, A. & Co., Ltd., Hebburn-on-Tyne

Dynamo Oil.
Willcox & Co., 36, Southwark-street, S.E.

Dynamos, Transformers, Meters, etc.
Allen, W. H., Son, & Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Morris-Hawkins, 30, St. Mary Axe, E.C.
Union Electric Co., Park-street, Southwark, London, S.E.

Ebonite and Vulcanite.
F. Carson & Evans, 3a, Fenchurch-buildings, London, E.C.
Mosses & Mitchell, 69, Chiswell-street, E.C.
North British Rubber Co., Ltd., Castle Mills, Edinburgh.
Traun, Dr. Heinr., & Son, 25, Goswell Road, London, E.C.

Electric Cooking Apparatus.
British Thomson-Houston Co., Rugby.
General Electric Co., 71, Queen Victoria-st.
British Prometheus Co., Ltd., Salop-street Works, Highgate, Birmingham.

Electrical Fittings and Appliances.
The Benjamin Electric, Ltd., 1a, Rosebery Avenue, London, E.C.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Dorman & Smith, Ordsal Station, Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Flexible Metallic Tubing Co., Ponders End, & 112, Queen Victoria-st., London, E.C.
General Electric Co., 71, Queen Victoria-st.
Lundberg, A. P., & Sons, Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Metallic Seamless Tube Co., Wiggin-street, Birmingham.

Electric Fans.
Edison & Swan United Electric Co., 36 & 37, Queen-street, Cheapside.
General Electric Co., 71, Queen Victoria street.
Gibbs, J. & Son, 72-76, Duke-street, Liverpool.

Electric Heaters.
British Prometheus Co., Ltd., Salop-street. Works, Highgate, Birmingham.
Bastian Electric Heating Syndicate, Ltd., 91-93, Palmerston House, E.C.

Electric Light Contractors.
British Thomson-Houston Co., Rugby.
Ferranti Limited, Hollinwood, Lancs.
Hooper's Telegraph & Indiarubber Works, 31, Lombard-st., E.C., & Millwall Docks.
Johnson & Phillips, Old Charlton, Kent.

Electric Light Fittings.
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.

Electric Locomotives.
British Thomson-Houston Co., Rugby.

Electric Radiators.
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.
Dowsing, 105, Gt. Portland St., W.

Elevating, Conveying Plant, Cranes, etc.
General Electric Co., 71, Queen Victoria-st.
British Westinghouse Electrical and Mfg. Co., Manchester.
Ferranti Limited, Hollinwood, Lancs.

Electric Signs.
Caspar Signs Co., 33, Kings-road, St. Pancras.

Engines.
Allen, W. H., Son, & Co., Queen's Engineering Works, Bedford.
Belliss & Morcom, Ledsam-street Works, Birmingham.
Crosley Bros., Ltd., Openshaw.
Willans & Robinson, Rugby.

Engine Accessories, Tanks, etc.
Babcock & Wilcox, 30, Farringdon-st., E.C.
Dore, J., & Co., High-st., Bromley-by-Bow.
Harvey, G. A., & Co., Lewisham, London, S.E.
Willcox & Co., 36, Southwark-street, S.E.

Engineers' Stores.
Willcox & Co., 36, Southwark-street, S.E.

Feed-Water Heaters.
Wilkinson, Geo., Beech Mount, Harrogate.

Fire Extinguishers.
Merryweather & Co., Greenwich, S.E.

Galvanisers.
Harvey, G. A., & Co., Lewisham, London, S.E.

Glassware. (Holophane, Etched, and Bead Shades).
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.

Indiarubber Goods.
Moseley, D., & Sons, Chapel Fields Works Ardwick, Manchester.
Willcox & Co., 36, Southwark-street, S.E.

Insulating Varnish.
Major & Co., Soulcoates, Hull.
Pinchin, Johnson & Co., Ltd., Bevis Marks, London, E.C.

Insulators and Insulating Materials.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
General Electric Co., 71, Queen Victoria-st.
Griffiths Bros., Mack's-rd., Bermondsey, S.E.
Hooper's Telegraph & Indiarubber Works, 31, Lombard-street, E.C., & Millwall Docks.
Johnson & Phillips, Old Charlton, Kent.
Macintyre, J., & Co., Washington China Works, Burslem.
Mosses & Mitchell, 69, Chiswell-street, E.C.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.
Traun, Dr. Heinr., & Son, 8, Redcross-street, London, E.C.

Jointing.
John Hudson & Co.'s Successors, 4, Victoria Warehouses, Mansell-street, E.

Ladders and Steps.
Heathman, J. H., & Co., Parson's Green, S.W.

Lamp Columns for Arc Lighting.
General Electric Co., 71, Queen Victoria-street, E.C.
Hardy & Padmore Ltd., Worcester.
Johnson & Phillips, Old Charlton, Kent.

Lamps: Arc & Metal Filaments.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Cryseloo Ltd., Kempston Works, Bedford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Eichner & Co., 29, Priory Avenue, Hornsey, N.
Feld Bros., 25, Rudge Row, Cannon Street.
General Electric Co., 71, Queen Victoria-st.
Imperial Lamp Works (Brimsdown), Ltd., Kingsway House, Kingsway, W.C., Works, Brimsdown, Middlesex.
Johnson & Phillips, Old Charlton, Kent.
Stearn Electric Lamp Co., 47, Victoria-st., S.W.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.
Union Electric Co., Park street, Southwark, London, S.E.

Lampholder Makers.
Dorman & Smith, Ordsal Station Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
General Electric Co., 71, Queen Victoria-st.

Lead-Covered Cables.
Callender's Cable & Construction Co., Hamilton House, Victoria Embank't, E.C.
Johnson & Phillips, Old Charlton, Kent.
London Electric Wire Co., Anchor Works, Playhouse-yard, E.C.

Manganesite.
John Hudson & Co.'s Successors, 4, Victoria Warehouses, Mansell-street, E.

Measuring Instruments—Electrical.
British Thomson-Houston Co., Rugby.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Ferranti Limited, Hollinwood, Lancs., E.C.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.

Metal Filament Lamps. ("Tantalum" and "Osmowatt").
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.

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Classified Directory—Manufacturers and Merchants *(continued)*:

Mechanical Stokers and Conveyors.
Babcock & Wilcox, 30, Farringdon-st., E.C.

Metal Perforators—Specialty, Lead.
Harvey, G. A., & Co., Lewisham, London, S.E.

Meters.
Bastian Meter Co., Bartholomew Works, Kentish Town, N.W.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.

Motors—Electric.
Allen, W. H., Son & Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Churton, T. H., & Co., Atlas Works, Leeds.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Electromotorenwerke, Heidenau, 15, Bez, Dresden.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Morris-Hawkins, 9½, Union-court, Old Broad-street, London, E.C.
Union Electric Co., Park-street, Southwark, London, S.E.

Motor Starters & Controllers.
Reyrolle, A. & Co., Ltd., Hebburn-on-Tyne

Mica.
British Mica Co., Lebanon-road Works, Wandsworth, S.W.
Taylor & Co., 40, Hatton-garden, E.C.
F. Wiggins & Sons, 102, 103 and 104, Minories, London.

Oilcans and Economisers.
Kaye, J., & Sons, Leeds.

Oils, Paint, &c.
Callender's Cable & Construction Co., Hamilton House, Victoria Embankment, E.C. "Kalbitum."

Oil Separators.
The Baker Oil Separator Co., Ltd., Hunslet, Leeds.

Packings—Asbestos and Metallic.
Hooper's Telegraph & Indiarubber Works, 31, Lombard-street, E.C., & Millwall Docks.
Klinger, R. & Co., 66, Fenchurch Street, London, E.C.
United States Metallic Packing Co., Soho Works, Bradford.
Willcox & Co., 36, Southwark-street, S.E.

Petrol Air Gas Plants.
Safety Light Ltd., 117, Middlesex Street, London, E.

Platinum Utensils.
Derby & Co., 44, Clerkenwell-road, E.C.

Projectors.
Johnson & Phillips, Old Charlton, Kent.

Pumps.
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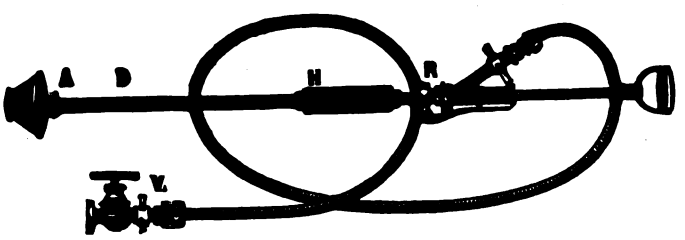

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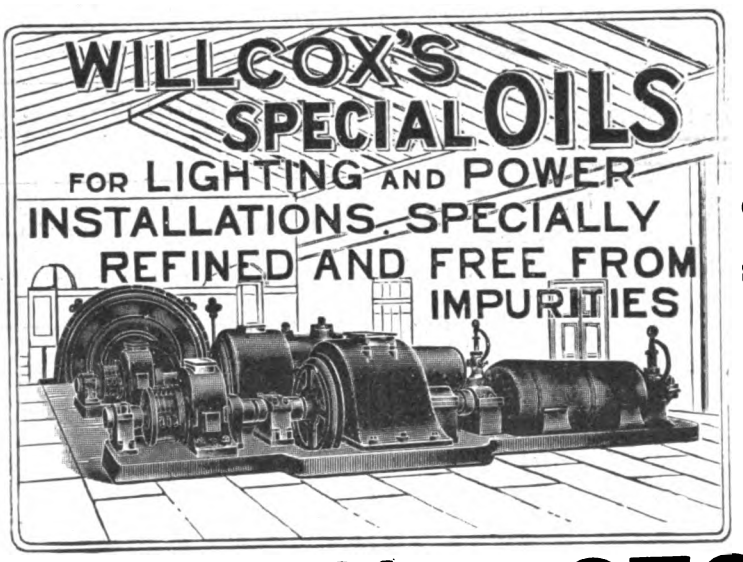

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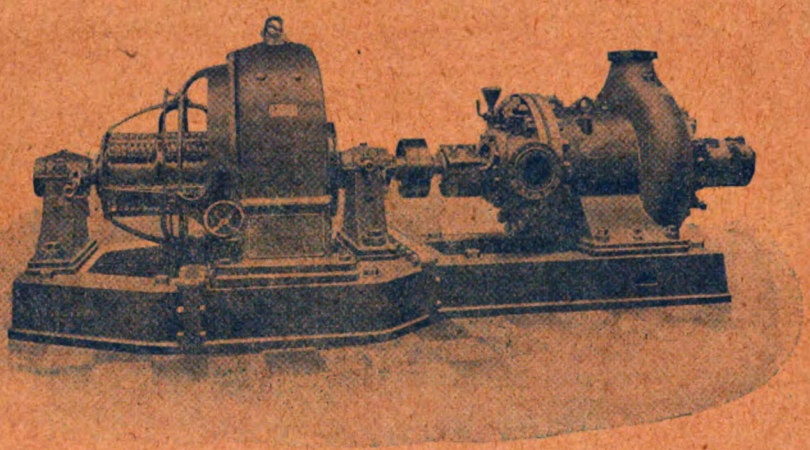

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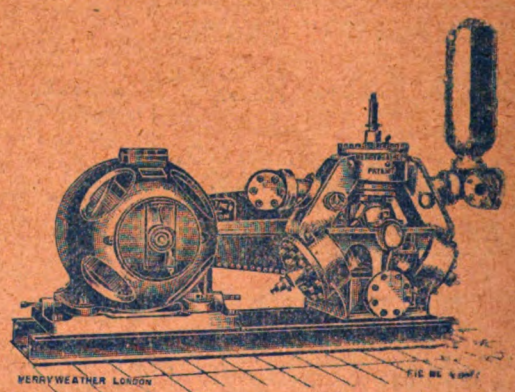

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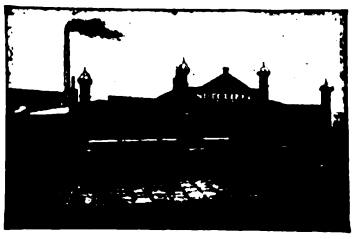

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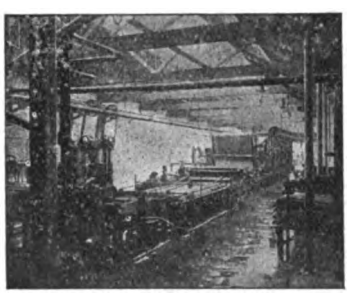

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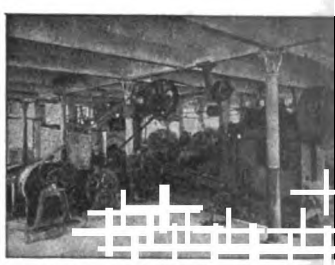

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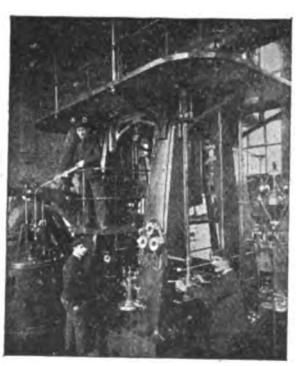

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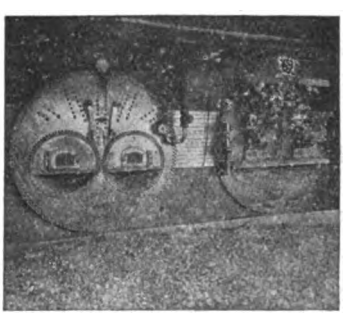

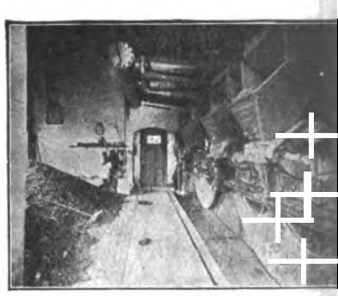

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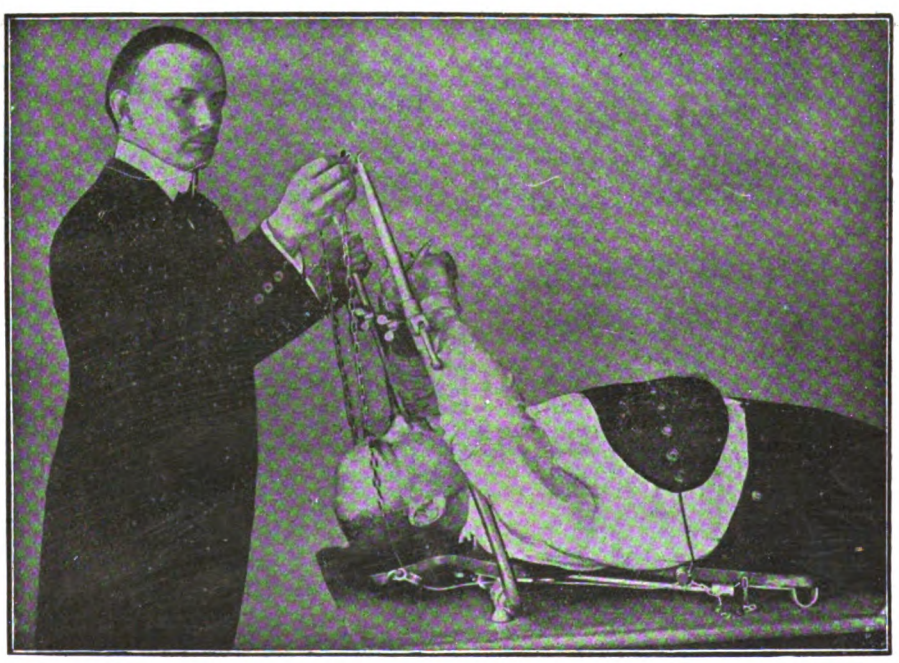

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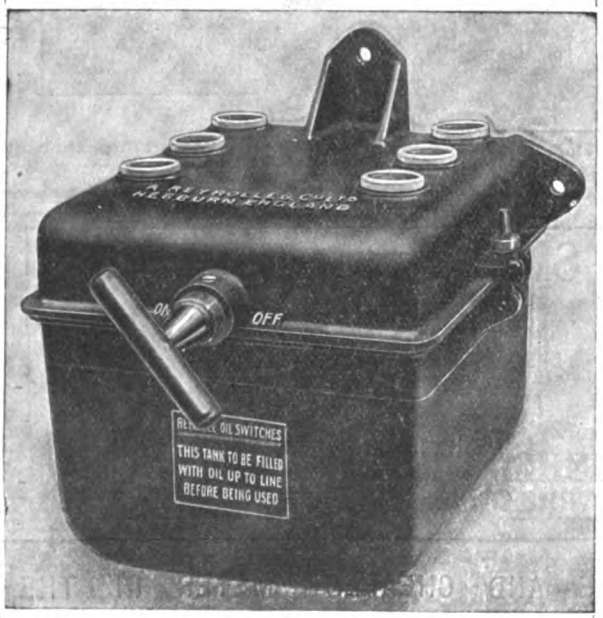

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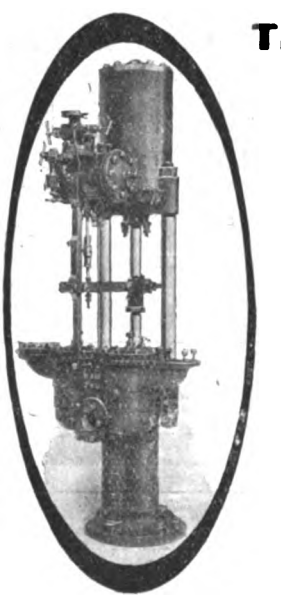

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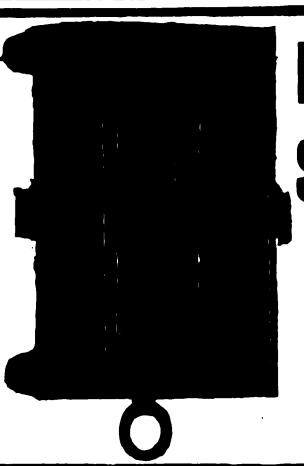

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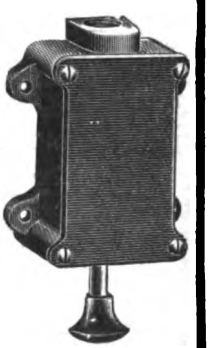

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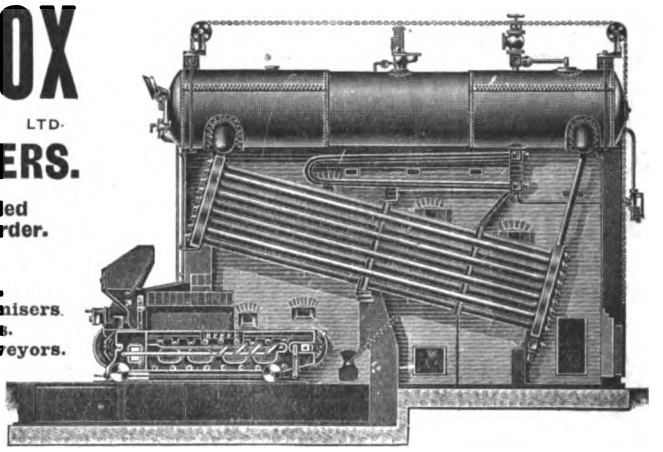

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NOTES.

WHILE there is little doubt that the projected Tube and Omnibus Combine will in due time materialise, the negotiations are not going on by any means too smoothly. With the exception of Mr. J. Howard Moore, all the directors of the London General Omnibus Company are in favour of the amalgamation, and it is confidently asserted that the majority of the shareholders are convinced that the project would be to their advantage, but when they were called together to pass the resolutions sanctioning the scheme a dramatic surprise awaited them. Mr. Joynson Hicks, the Company's solicitor, announced that Mr. Howard Moore, in conjunction with Mr. John Lee-Smith, had filed a suit against the Company alleging that the other directors had undertaken "in consideration of personal benefits to be conferred on them to hand over the control of the company to a rival and competing company," and they asked for an injunction to restrain the members of the board from summoning or holding meetings to give effect to the scheme or of creating any annuities or benefits to be conferred on the board. Mr. Hicks explained that in the event of the scheme going through, the Underground Electric Railways Company would require to put some of their own nominees on the board so as to manage the company in accordance with their own ideas, and they made it a condition that the directors must, if asked, give up their seats. They also insisted on the directors undertaking that they would not join the board of, or take any part in, any competing company. That was necessarily detrimental to them, and in consideration of that the Underground Company agreed that if the directors retired and gave the undertaking in question, they would use their votes to provide for them annuities out of the funds of this company. There was a cry of "Shame" at this, but Mr. Hicks said he was instructed by the board to enter an appearance to the writ and to give an absolute denial to the allegation that the directors had been unduly influenced by these personal benefits. Lt.-Colonel Colvile, the chairman, without saying anything which could be regarded as *sub judice*, rather cast ridicule on this application to the Court, and urged the shareholders not to listen to "croakers and those who had axes to grind." It was, he declared, "a 100 to 1 and no backers" that the scheme would go through. Mr. Howard Moore, who, it appears, was received with a good deal of cheering, defended his attitude on the ground that the scheme was wholly inequitable from their point of view and was nothing less than a surrender of their rights and privileges. In this he was warmly supported by Mr. March, who roundly denounced the project as "a wild cat scheme" under which they would be called on to give up the bulk of their profits to make up the Income bonds of the Underground Company. The proceedings came to an abortive end, no resolution being put either sanctioning or opposing the scheme. The application of Mr. Moore and the rest of the opposition comes up in the Courts to-day, and the proceedings should form interesting reading.

ALMOST simultaneously with these proceedings at the Omnibus Company's meeting, Sir Edgar Speyer was explaining the other side of the case to the shareholders of the Underground Electric Railways Company. He was very frank in his statements of the case. He expressed

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the conviction that the London General would accept the scheme, but even if they did not, the Underground would run feeder omnibuses of their own to supplement the tube and tramway services. While this has been regarded in some quarters as being in the nature of a veiled threat against the London General—a sort of "Your omnibuses or your routes," with a pistol held at their heads—the position is in reality a logical one, and wholly justifiable from the point of view of their policy. It is a little curious that while some of the omnibus shareholders were declaring that they would be making a bad bargain if they put themselves in the hands of the Underground, some of the railway shareholders were arguing that the Underground was running grave risks and going beyond the limits of prudence in ceding to the London General so much fresh capital and "saddling itself with so speculative a partner." Sir Edgar Speyer's view was that while the Underground was undoubtedly incurring "risks and uncertainties," they preferred those risks and uncertainties to running a motor omnibus service of their own.

A DEBATE which is likely to prove of considerable interest to electrical undertakings is to be raised in the coming Session of the House of Commons in respect of the Municipal gas industry. It is to turn on the authorisation given to Municipalities to supply outlying areas with gas and to make an extra charge for this supply in districts which took no share in the management of such undertakings and incurred no financial responsibility. This at the outset was, of course, fair enough; but in many districts the original cost of these gas undertakings has been wiped out by successful administration and in others has been very nearly liquidated, and large sums, in both cases, are allocated to the relief of rates. But while the ratepayers in the supply centre are thus reaping substantial benefits, consumers in the outlying areas are (in a double sense) paying through the nose for their gas. In other words, the profits made go in relief of town rates at the expense of the contributory districts which sometimes pay 4s. and 5s. per thousand cubic feet while the townsfolk are let off for 2s. 6d. and get their rates cut down into the bargain. This, it is contended, is a very inequitable, if not, indeed, iniquitous proceeding, and when the Salford Gas Bills come up for discussion it will be sought to establish the principle that no municipality ought to make profit out of its corporate undertakings beyond what is commercially sound business, and that the balance should be devoted to the reduction of the price to consumers, instead of by way of relief to ratepayers, who may or may not consume the article on which the profit is made. This is a principle which has been contended for in many directions in connection with Municipal electrical undertakings, and the proposed debate is likely to have a material bearing upon the future of these enterprises, since those who are responsible for raising the question in Parliament are determined to secure legislation in the subject if there is any possibility of doing so.

THE progress of the electric furnace is well illustrated by the paper which was read a few nights ago by Mr. Cecil Myers at the joint meeting of the Manchester Local Section of the Institution of Electrical Engineers and the Manchester Association of Engineers. Mr. Myers had no hesitation in expressing the view that for many purposes in steel making the electric furnace was the furnace of the future, especially if they looked back over the last ten years and saw the great strides it had made. In June, 1910, there were about one hundred and eighteen furnaces of all types, of which seventy were in active use, and the output of electric steel in Germany, the United States, Austria, and Hungary amounted to about 112,000 tons—an increase of 63,000 tons over the figures for 1909. There was no doubt now, he said, in the minds of steel makers who had actual experience of up-to-date furnaces that it was possible to make steel equal to the best ever produced in Sheffield at less cost than it could be done in the crucible. Pig iron could be produced of any grade and of satisfactory quality, and though the electric furnace could not compete with the blast furnace for this purpose in this and other countries where fuel was cheap, there was a considerable field for its development where cheap water power was available and where suitable fuel for the blast furnace could not be obtained.

IN this connection it is interesting to note that the Sheffield Electro-Metallurgical Society has resolved to widen its scope, and under the new title of the Sheffield Society of Applied Metallurgy is to extend its investigations to electro-metallurgy in practical engineering. Professor Arnold, who presided over the meeting at which this decision was come to, said this was the first step in a bigger scheme in relation to applied science which they had in view in connection with Sheffield University. He indicated that one of the questions shortly to be brought forward was the melting non-ferrous metals by electricity, and he announced that in the new non-ferrous department of the University provision was being made for electrical processes. They had a furnace which would melt 100 lbs. of non-ferrous metals. With regard to the economic conditions, what the University hoped to do was to get a fairly accurate idea of the working costs and conditions of the three methods, before manufacturers embarked upon futile expenditure. That, he took it, would be their function. With regard to the question of electrical energy in Sheffield, it was quite true, he said, that they lived in a region of plentiful fuel, but so did Newcastle. A region of plentiful fuel should also involve a region where there was plenty of electrical energy. Whereas Sheffield had to pay ·6 of a penny for current, Newcastle got it for a farthing. That would very much handicap the development of electrical melting in Sheffield, unless the Corporation could find some means of altering it, and expressed a strong hope that such an alteration might speedily come about. At the same meeting Mr. Frank Mason, in the course of an interesting paper, observed that the applications of electricity to the science of metallurgy were already wide and varied and increasing rapidly. The results of experimental work of such investigators as Davy and Faraday, amongst others, had placed the science of electro-metallurgy upon a firm basis of accurately observed phenomena and led to the enunciation of laws which more than half a century of progress had tended to confirm. Electro-metallurgy might be said to be that science which dealt with the extraction, melting, and separation of metals by the aid of electricity. It dated back to the beginning of the nineteenth century, but the practical applications of electricity to metallurgy were confined almost to the last thirty years. He surveyed the principles operating the electric furnace, and did not advocate the immediate total demolition of its elder brother of the fuel type. The conditions which existed to-day in and around Sheffield did not warrant such drastic measures being taken, if cost of production alone was considered. In this district nature had not distributed her favours very lavishly from the electric furnace advocate's standpoint. The district was blessed with cheap fuel, and almost a total absence of natural forces such as were to be found in the States or Switzerland and elsewhere. While these conditions existed, advantages in directions other than apparent cost must present themselves if the application of electricity was to commend itself to the non-ferrous metallurgist. It had been found that the electric furnace provided a means whereby large quantities of alloy might be produced at one heat, though this, of course, was not an advantage in all cases. The electric furnace reduced to a minimum losses by furnace and draughts. It enabled alloys to be obtained all uniform in composition, and greater accuracy was obtained in the composition of alloys.

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FOR the first time in history electricity has been utilised during the current week in an attempt to compare the nervous organism of the ape with that of man. The experiments were made at the Imperial Institute by Dr. Augustus Waller, F.R.S., and Dr. Vernon Boys, of London University, and the subjects were "Max" and "Moritz," the educated chimpanzees, whose amazing intelligence has been delighting large audiences of late at the London Hippodrome. "Moritz," after watching a youth go through the ordeal and come out unscathed, was induced to place his right hand in a bowl of salt water and his left foot in another. By these means the electrical apparatus was operated and the pulsations of the heart and nerves were shown on a screen, while at the same time a permanent record was obtained by means of the rotary photographic process. Dr. Waller says that the experiments showed that in passive moments certain pulsations of the systems of these anthropoids were as near the human pulse as it is possible to be, their relative association with the human race being thus established to a very disconcerting degree.

ELECTRICITY is being applied by Mr. Thorne Baker, the well-known "wireless" enthusiast, to the rearing of chickens, and so far as the experiments have gone—they have only been in progress some three weeks—they seem to have established the fact that the electrified chicken is far superior to the domestic fowl in its normal state. Mr. Thorne Baker says the chickens are being treated with about 5,000 volts, the current alternating 10,000 times a second. "One effect seems to have been to make the electrified chickens pugnacious, for this morning they were bickering amongst themselves to a reprehensible extent, the unelectrified ones remaining perfectly placid." This exuberance Mr. Thorne Baker attributes to the effect of the electricity on the blood, which possibly has been made to flow more freely through the brain, and, of course, the other organs as well. It appears to be something like feeding them with oxygen, but without any ill effects. The cost of the treatment works out at an eighth of a penny per chicken per week, so that if the results are good the price of obtaining them should not be excessive from the chicken farmer's point of view. The electricity is of somewhat similar character to that used in wireless telegraphy, and the chickens do not feel it any more than the wireless operators do.

THE amazing progress made by traction since the advent of electricity is strikingly illustrated by a White-paper which has just been issued by the Board of Trade. During the horse-car period the total number of miles of route open was 321. In the electric period, up to 1910-11 the mileage open was just under 2,600. During the same period the number of passengers carried has increased from 151,000,000 to nearly 3,000,000,000. The net receipts have increased from £230,956 to £5,276,060, and the capital expenditure from £4,207,350 to £75,672,826. The number of passengers carried in the year 1910-11 was equal to about 64 times the population of the United Kingdom. Out of a total of 1,744 miles of line owned by local authorities, 1,530 miles were worked by those authorities, or by other local authorities leasing from them and the remaining 214 miles by leasing companies. In the year under review the route mileage open of electric lines was 2,467 miles out of 2,597, the remainder being 5 per cent. of the total length of line. Of the 296 undertakings, 174 belonged to local authorities and 122 to companies or other parties. The net receipts of local authorities who work tramway undertakings belonging to them or leased from other local authorities amounted to £3,849,380 on the year's traffic, and they applied £1,178,795 towards the reduction of tramway debt and £370,435 in relief of rates, while carrying £888,639 to reserve and renewal funds. In the cases of only five local authorities and seven companies do the returns show an excess of working expenditure over gross receipts. The total gross receipts of street and road tramways and light railways in the United Kingdom was £13,777,001, including £13,197,394 from passengers, £61,586 from parcels and mails, £13,992 from animals, goods and minerals. Of the total £11,418,936 was received in England and Wales. The total working expenditure came to £8,500,941, which included £3,600,302 for traffic expenses, £1,778,767 cost of tractive power, £188,242 compensation for personal injury or accident insurance, £481,800 rates and taxes, and (under general repairs and maintenance) £658,194 for permanent way and £948,464 for cars and other rolling-stock. The appropriations comprised £1,962,118 for interest or dividend, £1,203,695 repayment of debt or sinking fund, and £1,139,458 reserve (including depreciation) and renewal fund. The net receipts of local authorities who work tramway undertakings belonging to them or leased from other local authorities amounted to £3,849,380 on the year's traffic, and they applied £1,178,795 towards the reduction of tramway debt and £370,435 in relief of rates, while carrying £888,639 to reserve and renewal funds.

Correspondence.

ELECTRIC NOTES ON INDUCTION MOTORS.

To the Editor of the ELECTRICAL ENGINEER.

Sir,—With reference to the interesting article on Induction Motors by Mr. J. S. Leese, in your issue of last week, one point has been brought to my notice, and as it occurs to me that the same little difficulty will have presented itself to the minds of other persons, perhaps Mr. Leese would for their benefit be good enough to amplify the information already given.

I refer to the first paragraph on page 89, where it is stated that for large motor feeders it is better to use several conductors in parallel rather than one single cable, and whilst this is sound advice from more than one point of view, there remains the question as to what constitutes a large motor within the meaning of—not the Act—but the word.

To some persons a 50 h.p. machine would be a large one, to others the term would refer to a machine of not less than say, 200 h.p., whilst others engaged on really heavy work would think of something over, say, 400 h.p. Reference should of course be made to the voltage of the system—on which the current and consequently the area of the cable—depends.

I might also mention another similar matter which has been found to be of much service, and it is that instead of using two limit gauges for testing the air gap, a set of feelers has been used. The thickness of these feelers is arranged from, say, the normal air gap down to about 5 mils, and by their use the more or less rapid wear of the bearings may be noted. These feelers cost, as a rule, rather more than a couple of limit gauges would, but in the majority of cases the extra few shillings would be well spent.

W. H. B.

LONDON ELECTRICAL ENGINEERS.—Officer commanding, Lieut.-Colonel H. M. Leaf. The following orders have been issued for the current week:—Monday, February 5—"A" Company: Lecture on Military Telephones, 8 to 9 p.m.; Technical Work and Musketry Instruction (standard tests), 9 to 10 p.m. Tuesday, February 6—"B" Company: Lecture on Military Telephones, 8 to 9 p.m.; Technical Work and Musketry Instruction (standard tests), 9 to 10 p.m. Thursday, February 8—"C" Company: Lecture on Military Telephones, 8 to 9 p.m.; Technical Work and Musketry Instruction (standard tests), 9 to 10 p.m. Friday, February 9—"D" Company: Lecture on Military Telephones, 8 to 9 p.m.; Technical Work and Musketry Instruction, 9 to 10 p.m. Saturday, February 10—Mobilization Week End Run: Members wishing to attend will notify O.C.'s Company as early as possible. The party will parade at Fenchurch-street Railway Station at 3.10 p.m. Dress: Service Dress, Great Coats, Haversacks and Belts. No arms will be taken.—(Signed) P. H. Campbell, Captain R.E. and Adjutant for O.C. London Electrical Engineers.

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The Institution of Electrical Engineers.

THE HEAT PATHS IN ELECTRICAL MACHINERY.

By Harold D. Symons, Associate Member, and Miles Walker, Member.*

If we wish to get the largest possible output from an electric generator or motor of given cost we must make a very close study of the possible methods of carrying away the heat which is produced in the iron and copper. The heat produced in any part (be it from I^2R loss or iron loss) has a definite path from the point of origin to the place where it is thrown out from the machine. Thus some of the I^2R losses in the armature conductors may have only to pass through a certain thickness of insulation to the air surrounding the coils, while the heat generated in the copper in the slots passes through the insulation to the iron where it meets with the heat produced in the iron, and both together are conducted to the ventilating ducts and carried by the air to the exterior.

We can imagine lines of heat-flow drawn through the machine which follow everywhere the paths of the heat from the point of origin to the point of discharge. At some points there may be constrictions in the path which it is desirable to avoid, at others the heat stream flows easily without undue temperature gradient. Everywhere at right angles to the lines of heat flow we can imagine isothermal surfaces constructed which enclose the points of highest temperature. If we are to even out these surfaces and lower the maximum temperatures, we must consider closely all the methods by which the heat is conveyed, whether it be by conduction, convection, or radiation.

The metals being good conductors, any heat produced in a mass of copper or iron distributes itself easily over the whole mass, but the insulating materials being poor heat conductors often cause excessive temperatures within the coils they enclose. It is desirable that the designer should have specific data as to the heat conductivity of every part of the machine in order that he may know what difference of temperature to expect between any two points in the heat path.

A good deal of useful work has been done on the measurement of temperatures inside shunt coils, on the heat conductivity of iron punchings at right angles to the plane of lamination and along the laminations; on the passage of heat from revolving cylinders to the surrounding air and on the passage of heat from various kinds of surfaces to air; but the authors were not able to find any direct data on the heat conductivity of electric insulating materials mounted in the same way as one usually finds them in electrical machines. They therefore thought that it would be worth while to make measurements both of the specific conductivity of the commonly employed insulating materials and of the effect on the conductivity of introducing the air spaces and gaps such as are often unavoidable in electrical machines. Two classes of tests were made. First a test by means of laboratory apparatus on the specific heat conductivity of materials mounted in different ways. Secondly, tests made on electric generators under actual running conditions.

The method of carrying out a test on any insulating material is described as follows: The material is wrapped around a copper cylinder, the thermo-couples for measuring the temperature of the outside are then fixed and wrapped over with the exterior copper sheet, the insulation is trimmed off the ends of the cylinder so as to fit well against the leather washers, the two wooden cheeks are fitted to the end of the cylinder and held firmly by long bolts. The whole is then immersed in the oil tank and the wires to the various couples connected to a multi-way switch and to the cold thermo-couple immersed in a bath of oil whose temperature is kept steady and measured by means of a thermometer. The difference of temperature between the hot and cold junctions was measured by one of R. W. Paul's millivoltmeters. This instrument, with a suitable resistance in circuit, will give the temperature in °C. direct if we employ couples composed of metals such a siron and eureka, which have an almost straight-line law over the range covered by the experiments. A known current at a known voltage is then passed through the resistance coil inside the copper tube, and the temperature of the oil in the bath is raised to the point at which it will remain steady under the conditions of the experiment. Readings of the temperature are taken at frequent intervals, and when they are found to be steady we know that the heat is being conducted through the insulation at the same rate as it is being supplied. The total heat flow through a certain area and thickness of insulation being known, and the difference of temperature at the two sides being known, the thermo conductivity can be calculated.

In other experiments the copper tube and insulation were placed in a wooden frame by means of which two draughts of air could be blown on to the material under test from opposite sides. The intensity of the draught of air was measured by means of anemometer and checked by measurements of the temperature of the air going in and the air coming out. This apparatus, besides giving measurements of the heat conductivity of insulation, gives us specific data for the cooling of surfaces when subjected to a draught of this kind under conditions somewhat resembling the conditions obtaining in some electrical machines.

It was found that all the cellulose materials such as cotton, paper, etc., had a considerable temperature coefficient. The heat conductivity at a temperature of 100° being about 12% higher than at 30° C. The heat conductivity of mica was not found to change between 20° and 100° C. Of all the fibrous materials commonly used in insulation the one having the highest thermal conductivity is empire cloth pressed into a solid mass free from air-spaces. This is probably because the fibres of the empire cloth are completely filled with oxidised varnish, whereas many of the papers, even when closely compressed, contain air-spaces. The difference in the conductivity obtained by winding the insulation on the copper cylinder very tightly and by winding it on loosely was very marked.

Very often a field coil insulated on the inside with layers of insulating material does not fit tight upon the pole, so that a short air-space exists between the insulation and the iron of the pole. It is interesting to inquire how far this air-space hinders the passage of heat. A number of experiments were made, in which air-spaces of different thicknesses were made between the copper tube in the testing apparatus and the insulating tube. These spaces were made by winding twine of different thicknesses in a wide spiral round the tube, and then winding the insulating material above the spiral. The thickness of the twine gave approximately the size of the air-space. It is to be expected that a very narrow air-space will have a greater thermal resistance per centimetre of thickness than a wider air-space, and as the space is widened out we come at last to a constant resistance (for 1 sq. cm. area of surface) which is the reciprocal of the cooling constant ($h = 0{\cdot}0011$) for surfaces exposed to still air.

A test was made on a 5,000 kw. 3-phase generator by means of thermo-couples placed in the armature coils during the course of construction. Each conductor, which consisted of two copper straps each 0·45 in. × 0·2 in., was insulated with tape and mica, a piece of mica 0·03 in. thick being added as a spacer. All four conductors were impregnated with gum and wound over with empire cloth and mica to a thickness of 0·13 in. The whole was then wound with linen tape. The total thickness of insulation amounted to 0·177 in. The various insulating materials were then present in the following proportions: Empire cloth, 0·07; mica, 0·03; varnish and air, 0·02; paper, 0·017; tape, 0·04. The heat conductivity of the insulation is easily calculated from the above figures. The total loss in the copper conductors per foot run of coil was 27·2 watts. In calculating

* Abstract of paper read before the Institution of Electrical Engineers, Victoria Embankment, January 25, 1912.

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this, allowance has been made for the rise in temperature of the copper due to the eddy currents produced in the conductors. The difference of temperature between the copper and iron is 20·6° C. Mean perimeter 6·8 in., so that the total area of insulation per foot run is 82 sq. in. With 27·2 watts per foot run this gives over 3 sq. in. per watt. The specific conductivity for heat of the insulation works out at 0·00112 watts per centimetre cube per degree. This conductivity is considerably lower than the figure (0·002) found from tests on empire cloth and mica wound on a copper cylinder with the fewest possible air-spaces, as can be easily understood. With coils of rectangular section wrapped with empire cloth and mica, or paper and mica, in the ordinary method, one may expect to have a heat conductivity not higher than 0·00112 watts per cubic centimetre per degree.

It sometimes happens that the copper conductors on an armature or field magnet are grouped together so closely that very little air can circulate between them, and the total cooling surface of the group is too small to dissipate the heat generated in it. In this case one relies mainly for cooling upon the conduction of heat along the conductors to parts of the coils where the cooling conditions are better.

There are three main cases occurring in electrical machinery in which it is necessary to calculate the rate of convection of heat from a solid surface to the surrounding air. (1) We have the case of an armature or field magnet of approximately cylindrical shape revolving within the stationary part of the machine. (Cooling coefficient denoted by h_v.) (2) We have the case of a field coil against which a draught of air is blowing. (Cooling coefficient denoted by h_d.) (3) We have the case of the iron isurface of a ventilating duct, through which the air is passing as a certain velocity. (Cooling coefficient denoted by h_r.)

The laws of cooling of the solid surface are different in the three cases. The first case (the cooling of the revolving cylinder) is very complicated. A formula for the close predetermination of temperatures would have to take into account, not only the square inches per watt and the peripheral speed, but also the length of the air-gap, the temperature and shape of the surrounding objects, as well as of the air, the nature of the cooling surface, and the rate at which the air in the gap is changed by artificial ventilation. What are we to take as the velocity of the air, relatively to the cylinder, when some air moves with the cylinder, some clings to the stationary part, and all intermediate velocities are to be found somewhere in the air-gap ?

When a cylinder revolves in air, the rate at which the air immediately in contact with it changes depends not only on the peripheral speed but on all sorts of accidental circumstances such as the shape of the stationary parts and the rate at which air is forced into the air-gap by the fanning action of other parts of the machine. A high relative velocity between rotor and stator is of service in causing the heat to pass easily from the heated surface to the air, but some further fanning action is necessary to remove the jacket of hot air away from the surface of the cylinder. In the case of field coils, an increase in the velocity of the current of air not only increases the intimacy of contact between the air and the surface of the coil, but at the same time increases the quantity of air passing the coil in a given time.

In predetermining the temperature rise of a wire-wound coil, we must first find the temperature rise of the external and internal surfaces of the coil. These will be the temperatures at which the coil can dissipate to the surrounding medium all the heat generated within it. In the next place we must find the rise of temperature of the hottest part above the external surface by taking into account the heat conductivity of the layers of insulated wire and the watts per cubic centimetre generated within the coil. Some designers make their shunt coils to be entirely air cooled. They provide such large air ducts between the coils and the poles that all heat passes to the air. Other designers make the coils a tight fit on the poles, and rely upon conduction of a large portion of the heat generated through the insulation to the body of the pole, whence it passes to the frame, or is dissipated from the pole-face.

After we have provided sufficiently well for the conduction of the heat through the insulation either to the air or to the iron surrounding it, the next question is how to provide sufficient cooling surface so that the heat may be communicated to the air and carried away by it. There are really two matters involved ; one is the provision of sufficient air to carry away the heat produced, and the other is the provision of cooling surface exposed in such a way as to heat up the air which passes through the machine.

We know that 1 cubic ft. of air per second (60 cubic ft. of air per minute), if raised in temperature 27° C., will carry away 1 kw. As a good deal of air sometimes passes through a machine without being raised much in temperature, it is usual to allow 100 cubic ft. of air per minute for each kilowatt loss. As or how this cooling surface is to be provided is a question upon which there has been a good deal of difference of opinion amongst designers. In the open type of machine where the paths for the air are not very definitely prescribed, and where the quantity of air passing is usually unknown, only the very roughest empirical rules can be used for determining the temperature rise. Where, however, definite paths for the air are provided in the machine and where the quantity of air passing is known, the cooling effectiveness of the surfaces can be approximately calculated.

In the cooling of large machines, such as turbo-generators, there are two general methods of providing paths for the air. According to one method, the air is passed through axial holes both in the rotor and in the stator, and it is the internal surface of these axial holes which mainly constitutes the surface exposed. Sometimes the air is passed from both sides of the machine towards the middle, and in other cases the air is passed from one end of the machine to the other. According to the second method the air is passed through a spider or through axial holes in the rotor, and thrown out through radial ducts in the rotor to radial ducts in the stator.

The first method has been commended on account of the fact that the iron punchings, whose conduction is better along the laminations than across the laminations, can convey the heat more easily to the air than where the ducts are of the radial type parallel to the plane of lamination.

The object of the experiments was to determine exactly how the air received its heat as it passed through a turbo-generator and to determine the value of h_v (the watts per square centimetre per ° C. difference of temperature between surface and air). At the same time it was sought to determine how far the cooling of the iron was hindered by the poorer conductivity of the punchings across the laminæ than along the laminæ.

As the value of h_v is dependent upon the v, and as it is the velocity of the air in intimate contact with the surface that is of chief importance, we may gather that for a given quantity of air passed through the machine narrow ducts will be more effective than wide holes. The ducts, however, must not be too narrow or they will be liable to be stopped up by the accumulation of dirt. Holes if too wide allow the air to pass without coming in close contact with the iron. It has been found that ventilating ducts from 0·3 in. to 0·4 in. wide having smooth iron walls will keep clean for a great number of years if the velocity of air passing through them is sufficiently great. A velocity of from 5 to 10 metres per second is sufficient to prevent the accumulation of dust in the absence of oil spray. If any oil is allowed to enter with the air the accumulation of dirt will be facilitated. It has been found that round axial ventilating holes of 2 in. or 3 in. in diameter whose walls are formed from the rough punchings accumulate the dirt very rapidly, this is particularly so with the holes in rotors where the centrifugal force can press particles of dust together on the internal surface of the hole furthest from the centre.

In cases where one cannot get rid of all the heat from the cylindrical surface of the armature and where it is therefore necessary to provide further cooling surface a radial ventilating duct is very effective. It enables an exceedingly large surface to be provided without unduly increasing the cost of the machine. Experiments made on a 1,875 k.v.a. generator showed that out of a total iron loss of 43·5 kw. 11·7 kw. was conveyed to the air by the cylindrical face of the armature, leaving 31·8 kw. to be carried away from ventilating ducts and from other exposed surfaces. It is calculated that 23 kw. of this was communicated to the air by the surface of the ducts and for this no less than 450,000 sq. cm. of cooling surface were required when the difference of temperature between iron and air was 9°. The difficulty of getting a sufficient quantity of air through

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a very long machine with a small air-gap can be met by adopting a scheme of ventilation in which certain channels are provided in the frame from which the air is forced inwards down the ducts to the air-gap and the rotor. Staggered with these channels are others which receive the air thrown outwards from the intervening sectors.

If we have a packet of iron punchings in which the loss per cubic centimetre is constant, and if all the heat generated is conducted across the packet and given off symmetrically to the air in the ventilating ducts which bound it on each side, the hottest part of the punchings will be in the centre, and the temperature gradient at any point within the iron will be proportional to x, the distance of the point from the centre. Let w be the watts lost per cubic centimetre, then $w\ d\ x$ will be the loss in a little part of the iron laminations 1 sq. cm. in area and $d\ x$ cm. thick. The total heat generated in a block 1 cm. high and 1 cm. wide, and of length x will be $w\ x$. If K_h is the heat conductivity in watts per square centimetre per ° C. difference of temperature per centimetre, the temperature gradient $\frac{d\ \theta}{d\ x}$ multiplied by the heat conductivity is equal to $w\ x$. As $\frac{d\ \theta}{d\ x}$ is negative when x is positive we—

$$-K_h \frac{d\ \theta}{d\ x} = w\ x.$$

$$\theta = \text{constant} - \frac{w}{2\ K_h} x^2.$$

In the experiment referred to the total iron loss amounted to 43·5 kw. Of this 4·5 kw. was in the teeth, and 36 kw. behind the teeth. The total volume of iron behind the teeth was 710,000 cubic cm.

Thus—

$$\frac{39{,}000}{710{,}000} = 0.055 \text{ watts per cubic centimetre} = w.$$

In arranging for the cooling of large electrical machines the following matters must be taken into account :—

Sufficient air must be provided to carry away the heat generated. If 100 cubic ft. of air per minute is provided for each kilowatt loss it will in general be sufficient. If the conductivity for heating of all parts is sufficiently good and the air is so distributed that none of it receives a temperature rise greater than 32° C. it may be that 60 cubic ft. of air per minute would be sufficient to keep the machine below 45° C. rise.

Sufficient cooling surface must be provided to communicate the heat to the air.

For ventilating ducts we may take the formula—

$$h_v = 0{\cdot}0014\ v.$$

Where h_v is the watts per square centimetre of cooling surface per ° C. the difference of temperature between surface and air and v is the mean velocity of the air in the duct and metres per second.

For the cooling of the surface of rotors and the internal cylindrical face of stators we may take the formula—

$$t^\circ = \frac{333 \times \text{watts per sq. cm.}}{(1 + 0{\cdot}1\ v)}$$

DISCUSSION.

Mr. A. H. Law recognised that the question of fans on large alternators was rather a difficult one, owing to the impossibility of obtaining decent efficiencies. He had utilised the same system of ventilation as Mr. Miles Walker had, upon machines up to 6,000 kw., but with a screw fan instead of a centrifugal fan. Mr. Miles Walker had referred to results on a 1,875 kw. machine, giving the efficiency of the fan at 2¼% with a small amount of air, and 19% with a large amount of air. Those results were about as high as could be anticipated with such a fan, but he thought that if a really efficient fan were used some 15 kw. or 20 kw. could be saved in the losses, and the rating of the plant might be increased by 10%. That, however, did not apply to small machines where it was inconvenient to instal separately-driven fans. He considered that the arrangement outlined by Mr. Miles Walker, in which the whole of the ventilating air was pumped into the rotor, gave the best results, as it allowed of most cooling in the rotor copper. Mr. Law did not think that the fact that the losses in the bundles of laminations near the centre of the stator were less than in the bundles of laminations near the end was due to the cause set forth in the paper.

Mr. E. H. Rayner observed that although air had the attraction of being very cheap, its density was so great that it required an enormous volume and a very large cross section of area in the machine to get the amount of air. Consequently it appeared that if water could be utilised instead of air there would be an advantage. He pointed out that 300 lbs. of air per minute were equal to 26 litres of water per second, but about half a litre of water per second would be enough to cool a 2,000 kw. machine. Water tubes of very small cross section in the stator would, he suggested, be more efficient than all the air now required. Possibly it might also be used for the rotor. Then, again, he suggested the possibility of completely immersing large generators in oil after the manner of a high tension transformer. Another method might be to make the conductors of the high tension winding in the form of tubes and pump either water or oil through them.

Mr. A. R. Everest remarked that there was a considerable difference in Mr. Miles Walker's figures relative to the heat jacketting effect of the insulation, as compared with the results given by other workers in this direction.

Mr. T. T. Sack said that the figures placed before them indicated that the thermal conductivity was almost proportional to the disruptive strength. It was rather astonishing to find that a micanite tube, consisting of nearly all mica, gave such a poor result. He, however, found that the percentage of shellac was rather high. He held that a good machine-wound micanite tube should not contain more than 5% of shellac. He regretted that the author did not give any results for leather or fibre as used in cables. The elimination of air spaces in the slot of an armature was of vital importance. Recently Messrs. Fleming and Johnson proved conclusively that chemical action could be almost entirely avoided if the air spaces were eliminated. Moreover, the puncture voltage was increased, and, in addition, as Mr. Miles Walker had shown, the thermo-conductivity was improved to an appreciable extent.

Mr. S. E. Glendenning emphasised the desirability of obtaining still further information regarding the permissible velocities in air ducts, size of passages, and so on.

Replying to the discussion, Mr. Miles Walker informed Mr. Law that really no very great reduction was noticed in the losses when the fan was removed. He did not know how Mr. Law arrived at the efficiency of the fan unless he knew the power taken to drive it when the machine was on and off. It was worth while using a specially designed fan with large alternators, but with smaller machines one did not care to spend £60 or £70 extra with a view to getting a slight increase in efficiency. Dealing with water-cooling, the author said that the A.E.G. had constructed such a machine, but he did not think it would come into common use until the machines got so large as to make it pay to have a proper system of pipes which could be made thoroughly watertight. The difficulties of oil immersion were so great that nobody had tried to carry it into practice. He was surprised that his figures agreed so well with previous results. The object had been to see how good a material was if the air was got rid of, and that was why mica came out good. Temperature measurements depended so much upon the conditions. As to the size of ducts, he suggested that a width of three-eighths or five-sixteenths of an inch struck a fairly happy medium.

The proceedings then closed.

STANDARDS FOR ELECTRICAL MACHINES.

Dr. Robert Pohl's Reply to the Discussion on his Paper.

The paper on "National and International Standards for Electrical Machinery" was read by Dr. Robert Pohl at the meeting of the Institution on December 7 (Electrical Engineer, Vol. xlviii, page 677). In the course of his full reply for publication in the "Journal," Dr. Pohl says :

I wish, in the first place, to reply to Mr. Hammond and to clear myself from the charge of having attacked the constitution of the Standards Committee. One speaker even thought I had made scathing remarks about its

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members. Needless to say, no such idea entered my mind; on the contrary, I cordially agree with the constitution of the sub-committee which formulated the standards of 1907, and have clearly pointed out that I would like to see the standards developed by a committee constituted on similar lines. It is for this very reason that I brought this paper forward here and not before the Association of Manufacturers, because any standards brought out by the Manufacturers' Association would not be backed up by the authority of a competent and independent body representing all the interests involved in this question. What I have stated, however, and what I maintain is, that the standards of 1907 represent the first and tentative step in the direction of standardisation and have in practice proved a complete failure. This latter fact was borne out by several speakers, and it cannot be denied. I will go further and say that other manufacturers complain with me that nothing further has been done since 1907, though most of them appear to be afraid to come forward and to stand here to be shot at.

Mr. Churton pointed out, and I agree with him, that he cannot standardise alternating current machines for all the frequencies prevailing in this country. I only suggested they should be standardised for 50 and 40 cycles. It is a very unfortunate circumstance that we have in this country so many frequencies, and this is due to the fact that we started standardising too late.

Mr. Robson thinks that unless manufacturers come to an understanding as regards selling prices we shall never be able to make profits. Whilst I fully agree with many of his reflections this is a point on which I disagree. In my opinion the prices of machines as sold in this country correspond to those at which they are sold in the open market of the world—in other words, they are to a large extent determined, I believe, by the price at which foreign-made machines are offered. It is frequently stated that selling prices are too low for manufacturers to make reasonable profits. But what I say is that our manufacturing costs are too high. We must learn from the methods of industrial organisation adopted abroad and bring our manufacturing costs down. By doing so we shall make profits because selling prices will not decrease in the same proportion, and our balance-sheets will look very much healthier at the end of the year. I do not believe in artificial means of raising manufacturers' profits by various legal, political, and other methods which have been suggested. I would not like to do away with the sting of either home or foreign competition, and thus to hide away our own weakness. We should learn by it and try to find out why those people can obviously make good profits in spite of low selling prices. It is not because the machines are bad, that is quite an exception. The fact is that, aided by standardisation, they have developed a higher form of industrial organisation, which means higher industrial efficiency. They manufacture in large numbers, whilst we continue to make individual machines. Instead of waiting for manufacturers to form a ring amongst themselves it would be very much better for all concerned, but especially for the general buying public, if an independent body, such as the Institution or the British Standards Committee, would take the first step in this matter and, by standardising not only performances, but also outputs and speeds, give small and large firms some of the advantages which the great American and German concerns derive from their organisation and vast production.

Dr. Thompson very rightly drew attention to the increasing demand for 115-volt machines for private installations. Nevertheless, the number of 115-volt dynamos made at the present time bears such a very small proportion to the total number of motors and dynamos manufactured that I considered myself justified in suggesting their elimination from the list of "standard" machines.

That Mr. Emmott as a consulting engineer is so fully in agreement with the proposals which I put forward is a matter of great satisfaction to me. I was somewhat afraid that consulting engineers might look askance at the suggested thorough standardisation, which, of course, means some curtailment of individual views. I was confident, however, that consulting engineers would ultimately agree that the adoption of standards which have been evolved by the consideration of a representative body such as this Institution or the British Standards Committee in is the interest of all parties concerned. Mr. Emmott's remarks fully bear this out.

Mr. Hartmell pointed out very clearly that what is wanted is a motor to do certain work and that it is foolish to specify, say, 25% overload for a great length of time or even continually. If we want a 10 h.p. motor to run at 20% overload continuously, we might as well call it a 12 h.p. machine.

I am obliged to Mr. Conder for raising the question of the flash test between phases of alternating-current machines. In my view the flash pressure to earth should also apply between phases where these phases are insulated from one another under working conditions: for instance, in the case of two-phase windings. For theoretical and practical reasons, however, a different test should apply for windings permanently joined at one or more points, such as three-phase windings. For such machines I suggest that an insulation test between phases might be carried out by raising the speed and over-exciting the field so as to obtain a pressure between the terminals 50% above the highest working pressure.

Several speakers expressed the view that it is too early for the inclusion of the flame-proof motor in the standards. I think that, on the contrary, definite explosion tests ought to have been prescribed long ago for all machines and apparatus sold as flame-proof. If the Institution had attended to this important matter as well as to the question of the "competent" colliery electrician in the way the Association of Mining Electrical Engineers is now doing, there would have been no cause for the scare as to the use of electricity in mines which has been reflected in recent legislation. Even one or two of the speakers appear to have been affected by that scare. It should be clearly recognised, however that the saving of human lives quite apart from the economic aspect, which is the indirect result of the use of labour-saving electrical appliances in mines must be infinitely greater than the number of fatal electrical accidents; the statistics how these latter to be surprisingly few. Electric machines for use in mines can be made as safe as miners' safety lamps, and there is no need for any special restrictions, provided that stringent tests are insisted upon to demonstrate that they are really flame-proof.

In conclusion, I wish to return to the larger aspect of the problem of standardisation. How great is the benefit that can be derived from it? Mr. Robson gave it as his opinion that the reduction in the cost of manufacture would not be as great as might be anticipated unless manufacturers agreed on a scheme of pooling and suitably distributing their orders. In my view Mr. Robson has, with these remarks, indicated the key to the whole situation. For years I have been of opinion that such a scheme of co-operation, which would immediately result in much lower cost of production, is not only from every point of view the most desirable, but also the most probable outcome of the industrial developments in this country. I estimate it would first of all mean a reduction in cost of as much as 25%. Those who doubt this may enquire whether any manufacturer would decline an order for, say, a thousand 20 h.p. 440 volt motors to comply with a safe specification such as outlined in my paper, at 25% below his ordinary selling prices, when there is, moreover, a practical certainty of regular repeat orders. The bulk of this saving would benefit the consumer, and the reduced prices would give a powerful impetus to our export trade and further accelerate the electrification of industries in this country and abroad. The pooling of orders could not without very great difficulties apply to anything but standard machines. Yet it is a well-known experience that with almost every large installation, special machinery is required as well as standard, and the demand for the former is therefore bound to go up as well as the latter. The scheme of co-operation outlined above represents in my view the healthy and desirable equivalent for trust and secret combines, and considering the low cost of raw materials and low cost of living resulting in a satisfactory level of wages, I see no reason why the British electrical industry should not develop into an exporting industry of the first magnitude, and why all the establishments, the total capacity of which is at present quite excessive, should not be kept

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fully, regularly, and profitably employed. It will probably take years, however, before the manufacturers will have become sufficiently educated to fall in with some such scheme of co-operation. At present most of them still think that the only way of getting orders is to take them away from their competitors. Nevertheless, co-operation for the economical production of standard machines is bound ultimately to take the place of wasteful competition. There can be no antagonism towards it because the prosperity of all sections of the electrical industry is bound up with that of the manufacturers. It is because I foresee this development that I have laid so much stress on the need for an independent and representative body drawing up not only a minimum standard of performance, but in addition a complete list of standard outputs and speeds.

THE PHYSICAL SOCIETY OF LONDON.

Note on a Negative Result Connected with Radio-Activity.

By J. H. Vincent, M.A., D.Sc., A.R.C.Sc., and A. Bursill, A.M.I.E.E.

The modern corpuscular theory of atomic constitution would lead us to admit the possibility of the production of instability in the atom by a strong magnetic field. It is also possible that an alternating field might prove more effective as a cause of instability than a steady field. The following research was consequently undertaken in order to find whether a high-frequency magnetic field causes substances to exhibit a measurable degree of radio-activity.

Experimental.

The substances experimented upon were bismuth, antimony, and iron, both para-magnetic and dia-magnetic substances thus being put to the test.

In order to measure the radio-active effect a Wilson gold-leaf electroscope was employed. In the early experiments the substance was placed about a centimetre away from a thin aluminium window in the walls of the electroscope, but in later work spurious effects were diminished by placing the specimen inside the instrument.

As the work proceeded it was found that the real difficulties of the investigation lay, not in making instruments sufficiently delicate to detect any radio-activity that might be produced, but in avoiding or compensating for spurious effects caused by the electrostatic influence of the oscillating charge, or the convection currents caused by the heating of the walls of the electroscope by the electric currents induced by the alternating magnetic field.

The form of electroscope, and the electrical connections finally adopted are shown in Fig. 1, in which the electroscope only is drawn to scale, the rest being purely diagrammatic. The gold-leaf system was contained in a brass case, the instrument being kept dry internally by a dish of calcium chloride. Fitted to the side of the electroscope was an ebonite tube, upon which was wound a coil (*b*) consisting of three turns of copper wire. This coil had a radius of 1 cm., and was thickly insulated with gutta-percha. A soldered connection was made from the middle turn of the coil (*b*) to the case of the electroscope, and the case was carefully connected to earth, these precautions being taken to prevent electrostatic effects as far as possible. For the same reason the ebonite tube upon which the coil was wound was painted internally with a thin coat of aluminium paint in order to render its surface slightly conducting. An ebonite plug was turned to fit the tube, and provided with two needle points. The specimens under test were powdered, and cemented to small pieces of cork which could readily be mounted on the needle points so as to be central in the coil.

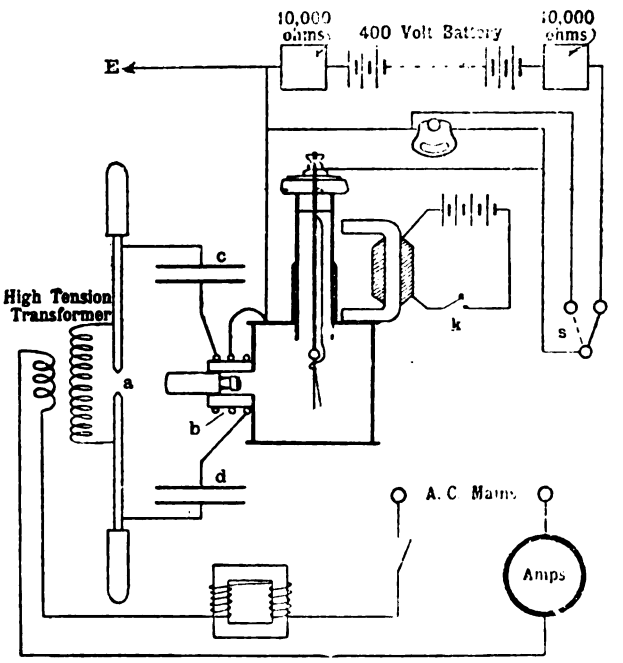
Two condensers (*c*) and (*d*), each having a capacity of 0·00145 microfarad, were connected in series with the coil surrounding the specimen under test. The capacity inductance circuit thus formed was connected across the spark-gap (*a*) of the secondary circuit of a high-tension transformer. This transformer had its primary coil connected to the 200 volt alternating current mains, a choking coil being placed in the circuit to prevent the current being excessive. Under these conditions the transformer was capable of developing 100,000 volts in the secondary circuit.

It will be seen that a spark passing across the spark-gap will give rise to electrical oscillations in the capacity inductance circuit, a current thus passing through the coil (*b*) having a high instantaneous value. In this way the specimen under test was subjected to a powerful magnetic field, alternating in direction with a high frequency.

The gold-leaf electroscope could be charged to any potential up to 400 volts, by means of a secondary battery consisting of 200 cells. The P.D. between the gold-leaf and the case of the electroscope when the instrument was being charged, was indicated on a multicellular electrostatic voltmeter, and was maintained constant during each set of experiments. Having charged the leaf by depressing the key (*k*), the brass wire above the sulphur bead in the electroscope could be disconnected from the battery, and earthed by means of the two-way switch (*s*).

Results.

In the last experiments performed the electroscope leaf was charged to —136·5 volts, and allowed to leak for two days. The mean rate of leak was 0·017 microscope divisions per minute. The actual curve of leakage was plotted by taking readings at frequent intervals, the initial rate of leak



being greater than this mean rate. A small crystal of uranium nitrate (about 0·1 gramme) introduced into the electroscope was found to discharge the gold-leaf almost immediately, the rate of leakage being too high to measure accurately.

Upon switching on the alternating current, with no specimen in the coil, the apparent rate of discharge was very much increased at first, but soon settled down to a value approaching the natural rate of leak. This initial motion of the gold-leaf was found to be due to the convection currents set up in the electroscope by the heating of its walls by induced electric currents. It was found that the convection effects ceased a few minutes after the current was switched off, and the leaf returned to the reading on the natural leakage curve.

The method adopted in looking for radio-active effects was to switch off the current, wait for the apparatus to reach a steady temperature and for convection currents to cease, and then take the electroscope reading.

Taking readings in this manner, the results indicated in all cases that the rates of leakage remained unaltered by the presence of bismuth, antimony and iron in the magnetic field. In conclusion, no evidence was obtained that radio-activity could be produced by the action of a magnetic field.

The health of Stalybridge is said to be much improved as a sequel to the gas supply being cut off for two days and nights.

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The Father of Electrical Science.

William Gilbert, of Colchester.

Notes, biographical and otherwise, of the early philosophers, writers, and navigators mentioned by him in "De Magnete." Some curious observations and opinions especially concerning the loadstone and several objects magnetical.

(*Continued from page* 87).

THEBIT BEN KORRAH—THABIT IBN CORRAH AL HARRANI—one of the most brilliant and accomplished scholars produced by the Arabs (836–901) called by Delambre "Le Ronsard de l'astronomie," is the author of many treatises on mathematics and on other scientific subjects, the bare mention of the titles of which take up nearly two folio pages of Casiri's Catalogue. Especially is he shown in latter as having translated into Arabic the chief works of Archimedes, Apollenius, Euclid and Ptolemy, also the Physics and Analytics of Aristotle and many of the works of Hippocrates and Galen. The allusions made to him by Gilbert are to be found in his books III and VI. In the last named, it is said that Thebitius, in order to establish a law for the great irregularities in the movements of the stars, held that the eighth sphere does not advance by continued motion from west to east but that it has a sort of tremulous motion "a movement of trepidation."

THEMISTIUS OF PAPHLAGONIA, surnamed EUPHRADES, was a distinguished Greek orator and writer of the latter half of the fourth century whose philosophical works consist of Commentaries in the form of paraphrases on some of Aristotle's writings, first published by Hermelaus Barbarus in 1481. Gilbert states that Themistius is wrong when, in book VIII of his paraphrase on Aristotle's *Physica*, he asserts that iron possesses the power of attraction only while in contact with the loadstone and that it is held of the stone but momentarily.

THEOPHRASTUS, Greek philosopher, born in Lesbes about 370 B.C., first observed the attractive property of the *lyncurium*, supposed by many to be the tourmaline, and gave a description of it in his treatise upon stones (*De Lapidus*, Sec. 53). This crystal was named *lapis lyncurius* by Pliny and *lapis electricus* by Linnaeus. Theophrastus is twice referred to by Gilbert in his first book and, when speaking of the *lapis lyncurius* he is made to say that that, like amber, it can attract straws, dried leaves, bark, and also attract small thin pieces of iron and copper.

ZOROASTER—ZARATH'USTRA—founder of the religious system contained in the *Zend-Avesta* (of the Parsee fire worshippers) is said to have been a great astrologer and magician, a native of Bactria near the modern Balkh and to have lived about B.C. 589–513. Many, however, doubt that he was an historical personage, equally with Buddha, Confucius and Mahomet. Gilbert's reference to him has been given in the Hermes entry.

ORIBASIUS was an eminent Greek physician born about 325 A.D. at Sardus, the capital of Lydia. Gilbert alludes to the treatment of the medical efficacy of loadstone and iron in chapter 13 of Oribasius' *De facultate metallicorum* which is embodied in one of the only three authentic treatises of him that have reached us. The first of these treatises is part of a compilation relative to seventy medical books, the second is a synopsis or rather an abridgement of the first, and the third is called *Euporistes* or manual of practical medicine.

ORPHEUS, to whom Gilbert alludes in his first, second and fifth books, is supposed to be the Vedic Ribhu. Orpheus already mentioned in the Kermas entry, is a very important figure in Greek legend, whose existence is denied by Aristotle, but to whom many writing such as *Argonautica, Bacchia, Lythica*, etc., are attributed. It is to the last named work that Gilbert makes special reference with regard to the drawing of iron by the loadstone.

PARACELSUS (PHILIPP THEOPHRASTVS BOMBAST VON HOHENHEIM)—1490–1541—was a native of Switzerland, one of the greatest chemists of his time, and founder of the school of mediæval magico-theury. The many vagaries of Paracelsus lost for him the respect of Gilbert whose references are to be found in his first and second books. Paracelsus declared that the loadstone's force and energy may be increased and transformed to ten-fold what it is naturally by half-candescifying the loadstone, *i.e.*, making it very hot yet so that it does not reach white heat, then immediately dipping it in oil of vitriol made from the best Corynthian steel and letting it become saturated. In this way, Paracelsus says: "you can give to a loadstone such strength that it will pull a nail out of a wall and perform many other like marvels impossible for a common loadstone." Elsewhere, he says that "any loadstone which mercury hath but touched, or which has been smeered with mercurial oyle, or even only put into mercury, will never again draw iron." Paracelsus, like Nicolaus and the Augsburg doctors, makes loadstone an ingredient of plasters for fresh wounds and stabs. Because of the exsiccating effect of the loadstone without corrosion, he says, it becomes an efficacious and useful remedy.

PARMENIDES OF ELEA, an eminent philosopher native of Southern Italy, living in the fifth century A.D. and the most prominent of the followers of the Eleatic school, founded by Xenophanes, has embodied a brief summary of his tenets in a work called *Nature, Proem, Truth, Opinion*. Gilbert's allusion to him is at Ch. 12, of Bk. V, where he says that the ancient philosophers, as Thales, Heraclitus, Anaxagoras, Archelaus, Pythagoras, Empedocles, Parmenides, Plato and all the Platonists—nor Greek philosophers alone but also the Egyptian and Chaldean—all seek in the world a certain universal soul and declare the whole world to be endowed with a soul.

PAULUM VENETUM—MARCO POLO (as indicated by his oldest recognized portrait which is inscribed *Marcus Polus Venetus Totius Orbis et Indie Peregrator Primus*) was doubtless the most celebrated of all travellers. He was born about 1256 in Venice, where he died during 1323. His first biographer was Gion Battista Ramusio (1485–1557), and Gilbert twice mentions him saying that he learned the art of the compass in China about the year 1260. The idea that the compass was introduced into Europe by Marco Polo, remarks Humbolt, is not supported by any evidence, for he returned to Italy after it had been mentioned as a long known instrument by both Guiot de Provins and Jacques de Vitry. Incidentally, it may be added that Polo's journeyings extended 'so far to the North that he leaves the North Star behind him, and thence so far to the South that the North Star is never seen"

PAULUS VENETUS—FRA PAOLO SARPI—"the greatest of the Venetians" (1552–1623), author of the celebrated *History of the Council of Trent* ("the rarest piece of history the world ever saw"), is referred to by Gilbert in his first chapter. Of Sarpi, John Baptista Porta says: "I never saw any man more advanced, or more ingenious, having attained the whole body of learning: he is not only the splendour and ornament of Venice or Italy but of the whole world." Bertelli tells us that Sarpi was acquainted with most of the magnetic phenomena referred to by Porta and still more developed by Gilbert and that he was the first to discover that fire destroys magnetic properties. It was from him, according to Gilbert, that Porta acquired much of what he subsequently wrote concerning the loadstone's obvious properties.

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PEREGRINUS, PETRUS—PIERRE PELERIN DE MARICOURT—we are told by Roger Bacon, was the only one, besides Master John (Peckham) of London, who at the time understood the business of experimenting in natural philosophy, alchemy and medicine better than anyone else in Western Europe. Peregrinus is the author of the very earliest known work of experimental science, written during 1269, in which he has satisfactorily developed, in connected series, all of the early experiments upon which are based his theories of the loadstone. Peregrinus devised an improved floating compas, also the first known pivoted compass and a wheel intended to show perpetual motion. To him is due the first inception of the *terrella* appropriated by Gilbert who very frequently alludes to Peregrinus in Books I, II, III, IV and VI.

PHILOLAUS PYTHAGORICUS was born at Crotona and flourished about 374 B.C. He was a disciple of Archytes and, next to him, was the most illustrious of the Pythagorean philosophers. He was the first known writer on the subject of physics and it is said his writings were so highly esteemed that Plato employed three books of Philolaus for the composition of his *Timaeus*. Gilbert says that Philolaus, whom he calls an illustrious mathematician and a very experienced investigator of nature, would have the earth to be one of the stars and to turn in an oblique circle toward the (central) fire, just as the sun and moon have their paths.

The seven systems of ancient astronomy, as explained by the author, P. Mansion, show the centre of the world to be, according to Philolaus, a central fire or vital flame of the entire planetary system, whilst Eudoxes, Ptolemaous and Tycho Brahe believed it be the earth immovable. Heraclides Pontus asserted that it was the earth rotating from West to East ; and both Aristarchus and Copernicus that it was the sun. The Eudoxes above named was called by Cicero the greatest astronomer known up to that period.

PHILOSTRATUS, FLAVIUS, to whom Gilbert alludes at chapter 38 of his second book, was a celebrated Greek sophist born at Lemnos about 175 A.D. Philostratus affirmed amongst other things that the precious stone *pantarbes* attracts to itself other stones, and Appolonius of Tyana, a Pythagorean philosopher living in the first century, reports having seen in India that same stone casting rays of fire and attracting to it all other gems which adhered to it like swarms of bees.

PICTORIUS (QUINTUS FABIUS PICTOR) " the father of Roman History," a patrician and a senator, according to Gilbert, asserts that the holding of a white loadstone gives one favour and acceptance with princes and that it makes one eloquent.

PLANCIUS, PETER, alluded to in Edward Wright's address to William Gilbert, was a Dutch theologian and astronomer—" a most diligent student, not so much of geography as of magnetic observations "—(1552–1622), the first to recommend the Dutch expeditions to the Indies and who prepared the maps and instructions necessary to ensure their success.

PLATO, a Greek philosopher, " the father of Idealism " (B.C. 427–347). He is frequently alluded to in *De Magnete* and mention is made of the *Io* wherein he praises the loadstone, holding its magnetic virtue to be divine. Plato says the magnet draws to itself iron and not only attracts iron rings but also endows them with the power of doing as the stone itself, to wit, of attracting other rings and that thus sometimes a long chain of iron objects, as nails or rings, is made : the several parts hanging from one another. In the *Timœus*, Plato says, " With respect to all the motions of water, the fallings of thunder, and the wonderful circumstances observed in the attraction of amber and of the Herculean stone—in all these no real attraction takes place at all, but as a vacuum can nowhere be found, the particles are mutually impelled by each other : hence as they all individually, both in a separate and mingled state, have an attraction for their own proper seats, it is by the mutual intermingling of those affections, that such admirable effects present themselves to the view of the accurate investigator."

PLINY—CAIUS PLINIUS SECUNDUS—(23–79 A.D.) is the author of the *Historia Naturalis* to which Gilbert (Bk. II, Ch. 38) makes many allusions. Pliny quotes from Sotacus five kinds of loadstone, viz : those of Ethiopia, Macedonia, Beotia, Troas and Asia, which were the chief sorts known to the ancients. He speaks also of the possible suspension in midair of Arsinoe's statue by means of the magnet and he relates the story that in India are two mountains near the river Indus, one of which, consisting of loadstones, possesses the power of holding everything containing iron, while the other, consisting of *theamedes*, repels the same (just as is stated in Cardan's *De Subtilitate*). Pliny and Julius Solinus tell of the stone *cathochites* and affirm that it attracts flesh and that it holds one's hand in same manner as loadstone holds iron, and as amber holds chaff.

PLOTINUS, OF LYCOPOLIS, in Egypt (A.D. 205–270) is the father of the Neo-Platonic School, the first division of which treats with the high origin and departure of the human soul and the second of the manner in which the soul may once more return to the Eternal. The fire-firmament of Plotinus is alone referred to by Gilbert in the third chapter of the last book of *De Magnete*.

PLUTARCH, already mentioned at the Aristotle entry, was one of the most popular writers of antiquity (50–120 A.D.). We are told by Gilbert that Plutarch and Caius Ptolemy, also many who came after them, believed that when the loadstone was rubbed with garlic it could not attract iron ; also, that Plutarch in his *Quaestiones Platonicae* asserts there is in amber something flame-like, or having the nature of the breath, and that this, when the paths are cleared by friction of the surface, is emitted and attracts bodies. He therein likewise says that the loadstone emits heavy exhalations whereby the contiguous air, being impelled, makes dense the air in front of it and that air driven round in a circle and returning to the part whence the air was displaced forcibly carries the iron with it.

PORTA, JOANNES BAPTISTA—GIAMBATTISTA DELLA PORTA—(1540–1615) an Italian Natural philosopher and a very prolific writer, receives from Gilbert more references than anyone else. These references are made in Bk. I, Ch. 1, 7 : Bk. II, Ch. 3, 4, 5, 24, 25, 27, 32 : Bk. III, Ch. 13, 14, 17 : Bk. IV, Ch. 9, wherein is mentioned the fact that Porta makes the seventh book of his *Magia Naturalis* a very storehouse and repertory of magnetic wonders. . . . Of the latter truly extraordinary work, as many as eighteen separate editions in different languages appeared prior to the year 1600. Gilbert says that in Porta's opinion the loadstone appears to be a mixture of stone and iron, *i.e.*, ferruginous stone or stony iron. " The stone is not changed into iron so as to lose its own nature, nor is the iron merged into stone, but that it retains its own essence, and, while each strives to overcome each, from the struggle there results attraction of the iron. . . . The loadstone does not attract stones : it has no need of them, there being stone enough in its mass, and if one loadstone attracts another that is not for the sake of the stone but of the iron shut up in the stone." Magnetic bodies held pendent in air drop to the ground when the opposite pole of a loadstone is presented to them : and this not because there is any weakening or numbing of the forces of both of the bodies before conjoined, as Baptista Porta maintains, for pole cannot be hostile to both of the ends that cohere, but to one only.

To be continued.

ELECTRIC MINERS' LAMP.

Mr. Cowper-Coles is introducing a new electric Miners' lamp which has several new features. It is capable of giving two candle power for over ten hours, and is fitted with two electric light bulbs, one being arranged to give a diffused light, and the other placed in a parabolic mirror which enable a concentrated beam of light to be thrown in any desired direction. The parabolic mirror is golden coloured so as to give a yellow beam of light which is less trying to the eyes and does not throw such deep shadows. The lamp bulbs are also provided with special screens so that in the event of breakage there is no risk of inflammable gases being ignited. The complete lamp weighs 4 lbs 5 ozs.

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Measuring Electric Current in Absolute Units.

Under the title "A Determination of the International Ampere in Absolute Measure," Messrs. E. B. Rosa, N. E. Dorsey and J. M. Miller have reported to the Washington Academy of Sciences their work at the Bureau of Standards. The absolute unit of current in the electromagnetic system is defined in terms of the magnetic field which it produces. Hence we can measure current in absolute units by measuring the magnetic field due to the current, or by measuring the ratio between this field and some other field which is measurable, as, for example, the earth's magnetic field.

The comparison may be made by means of the tangent galvanometer, and is often called the tangent-galvanometer method. Or, we can calculate the force of attraction between circuits carrying electrical currents, and determine the current by measuring the forces of attraction experimentally; this is called the electrodynamometer or current-balance method. The potential energy of two circuits relative to one another is equal to I_1I_2M where I_1 and I_2 are the strengths of the currents flowing in the two circuits, and M is the flux of magnetic force through one circuit produced by a unit current in the other, that is, the mutual inductance. The force or torque between the two circuits tending to produce a displacement is measured by the rate of change of the potential energy. If the currents are constant, we have to consider, therefore, only the rate of change of the mutual inductance. If a particular displacement be represented by a change dx in the variable x, and the current is the same in the two circuits, the force

$$F = I^2 \, dM/dx = KI^2,$$

where K is a function only of the ratios of the dimensions of the electrical circuit. To measure the current I, the force F must be measured and K must be determined. As to the method of measuring F and determining K, the various types of instruments differ.

The force or torque may be balanced by (a) the elastic deformation of a wire or fibre; (b) the gravitational attraction of the earth. Then the torque or force must in turn be evaluated in absolute units.

K may be determined in three ways: (c) by measurements of the separate dimensions of the instrument; (d) by comparisons of the instrument with some other instrument, the dimensions of which can better be measured; (e) by measurements of the ratios of the dimensions which enter into K. The accuracy attainable with the instrument depends upon the possible accuracy of these determinations.

The method (a) requires a direct determination of the force of restitution of the deformed body (generally a fibre) as it was used in the electrical measurements. The elastic after-effects shown by all material bodies introduce formidable difficulties.

The method (b) requires the measurement of a force by weighing, and the absolute value of the acceleration of gravity. The first is capable of extreme precision. An accurate determination of the second is very difficult, but results obtained with this method at different times and places can be very accurately compared by relative determinations of the acceleration of gravity and may be corrected at any time when the absolute value is determined to a higher degree of accuracy.

The determination of the constant K by the method given in (c) requires that the geometrical form of the apparatus be simple and the dimensions relatively large. Thus, the use of single-layer coils is necessitated in general. The forces of attraction are usually small and can, therefore, be measured accurately only with difficulty. Furthermore, the constant is determined once for all, and must be assumed to remain constant.

The method (d) allows the use of multiple-layer coils and some other features which tend to give a high sensibility in non-absolute instruments. The limitations of simplicity of form are, however, imposed upon a second apparatus with which the instrument itself is compared.

The method (e) allows the use of multiple-layer coils and the resulting high sensibility. The ratios which enter into the constant of the instrument may be determined experimentally by methods which are comparative and allow an extreme precision. The constant can be re-determined at any time.

The Rayleigh type of current balance as used in this work embodies the advantages of the methods (b) and (c). It consists essentially of three multiple-layer coils of square cross-section; two large fixed coils and a smaller moving coil. All of the coils are coaxial and their planes are horizontal. In this work three pairs of fixed coils (50, 50 and 40 centimeters in diameter) and three moving coils (25, 25 and 20 centimeters) were used. The moving coil was suspended midway between the other two from one pan of a precision balance. The current was led in and out of the moving coil at the balance pan by means of fifty silver wires. These wires were slack, and, on account of their fineness, did not interfere sensibly with the oscillations of the balance.

The force exerted upon the moving coil by the current in the fixed coils was weighed by means of the balance, as follows: The strength and the direction of the current in the coils were arranged so that the moving coil was pulled down by a force of about three grams. This force and the weight of the moving coil were counterbalanced. Then the rest point a of the balance was determined. The current was then reversed in the fixed coils alone. The force then became a pull up instead of down, giving a change of about six grams. A weight of six grams was put on one pan of the balance from which the moving coil was suspended, and very nearly compensated for the change in the force. Another rest point b was taken, the difference between a and b gave the difference between six grams and twice the electrical force upon the moving coil. The drift of the balance was eliminated by taking a series of the rest points a and b and plotting these against the time.

The determination of the force in absolute units required the knowledge of the absolute value of the acceleration of gravity. The value at the Bureau of Standards was determined in terms of the value at the United States Coast and Geodetic Survey by William H. Berger. G. R. Putnam, of the Survey, has connected the latter value with Potsdam by relative pendulum observations. Thus, the value at the Bureau of Standards has been referred to Potsdam, where, as the result of a long series of observations, the absolute value is believed to be known to three parts in a million. On this basis, the absolute value at the current balance is 980·091 centimeters per second per second, and is probably correct to five or six parts in a million.

As seen before, the constant K is the rate of change of the mutual inductance with the displacement of one circuit in that direction in which we wish to determine the force. In the present case, then, K is the rate of change of the mutual inductance of two co-axial circular coils, with the displacement of one coil in the direction of the common axis. Furthermore, at a certain distance the force is a maximum, and the coils of the Bureau of Standards current balance were spaced so that this condition was satisfied. In this case the force becomes practically a function determined solely by the ratio of the radii of the two circles.

The determination of this ratio is then the important point in the determination of the constant of the instrument It was determined experimentally by methods which admit of extreme accuracy. The coils to be compared were adjusted concentric and coplanar, with their planes vertical and in the magnetic meridian. Most of these adjustments were made experimentally. Currents were then passed through the two coils in opposite sense and adjusted until the resultant magnetic field at the centre was zero. This was indicated by a magnetometer needle, two millimeters long. The ratio of the two currents which balance each other in this manner is equal to the inverse ratio of the galvanometer constants of the two coils, excepting for a small correction on account of the length of the needle. The ratio of the galvanometer constants gives the ratio of the two mean radii when the numbers of turns and the sectional dimensions of the coils are known.

The ratio of the current was measured in two ways. The first method consisted in a simultaneous measurement of the two currents by means of two potentiometers. The second method was employed in cases where, as designed, the coils had nearly the same galvanometer constants. In this method the two coils are joined in series in such a manner that the current flows through them in opposite

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sense, one being shunted for a balance. As used in this work, both methods permitted an accuracy of about two parts in a million.

One of the features of the current balance which contributed very strongly to the attainment of a high accuracy is the water cooling system. In each of the fixed coils there is a channel back of the windings through which water can be circulated to carry away the heat generated by the electric current. The supply of water was held at a constant temperature by means of a thermostat, thus maintaining the coils at a constant temperature and radius. Water circulated through the fixed coils while the constant was being determined and when weighings of the force were being made. During the latter experiment the moving coil was surrounded by a copper water jacket through which water from the same course was circulated. This served the purpose of carrying away the heat generated in the moving coil and also made constant the convection currents of air which were set up by the heating of the coil. The possible accuracy in the weighing was thereby considerably increased. By the method of weighing, the constant lifting force of the currents of air was eliminated.

The rest points of the balance were read by means of a telescope and scale and a small mirror mounted upon the central knife edge of the balance.

Since the intensity of a current cannot be represented by a concrete standard, two expedients have been adopted to preserve the results of the absolute measurement of current. One is to determine the mass of silver deposited per second in a silver voltameter by a current of one absolute ampere, the other is to determine the electromotive force of a standard cell in terms of a standard of resistance and the absolute ampere. In this work the electromotive force of the Weston normal cell at 20 degrees Centigrade was determined in terms of the international ohm and the absolute ampere. The authors have called the unit of electromotive force a semi-absolute volt. Also, the final result has been expressed in terms of the electrochemical equivalent of silver as determined by a large number of observations with two types of voltameters at the Bureau of Standards.

In the final work four combinations of coils were used, besides one which was not used in taking the mean, owing to a very slight uncertainty in its cross-sectional area.

The conclusion is that the electromotive force of the Bureau of Standards concrete realization of the mean Weston normal cell at 20 degrees Centigrade, was 1·01822 semi-absolute volts. We believe that it is a conservative estimate to assign to the value given above a possible uncertainty due to all causes of two in 100,000.

Other observers in England, France and Holland have recently published results obtained by means of various types of instruments. When reduced to the same basis as used above, the values obtained are as follows:—

Date.	Observers.	Volts.
1907	Ayrton, Mather and Smith	1·01818
1908	Janet, Laporte and Jouaust	1·01834
1908	Guillet	1·01812
1908	Pellat	1·01831
1910	Haga and Boerema	1·01825
Mean	.. ..	1·01824

The absolute value of the electro-chemical equivalent of silver as obtained from the current balance of the Bureau of Standards and 159 silver deposits made by Rosa, Vinal and McDaniel in this laboratory with two types of voltmeters is 1·11804 milligrams per coulomb. The value adopted by the London Conference in 1908 was 1·11800. In other words, the international ampere as defined by means of the silver voltameter, as used by the Bureau of Standards, differs from the absolute ampere, as realized there by means of the current balance, by only four parts in 100,000. When the absolute value of the international ohm is as accurately known as the absolute value of the international ampere is now known, the watt can be realized with high precision from the international watt, by applying as a correction the small difference between them. Even now the most accurate way of measuring energy or power in absolute units is by means of electrical instruments.

THE CENTRAL HEATING AND POWER PLANT OF McGILL UNIVERSITY.*

By R. J. Durley, B.Sc., Ma.E., M.Inst.C.E.

Economic and other conditions have led in many places to the development of central plants for the distribution of heat to large groups of buildings or to districts in towns, and these installations are in successful operation both with and without accompanying electric generating-stations.

The present paper describes the arrangement and equipment of a central heating-plant, combined with an electric light and power station, designed to serve the various buildings of McGill University, at Montreal. Although only of moderate size, the installation is of interest on account of the somewhat severe climatic conditions and the unusual nature of the service. Attention is called to the fact that the economic possibilities of such a station depend very largely on the relation between the demand for heat and that for electric current.

The University buildings were, up to 1908, heated individually by their own steam or hot water equipment, and took current from the local electric supply company. The coal used for the heating service was necessarily of an expensive kind, and the cost of current was rather high. Economy and improvement in service, therefore, were sought by utilising cheaper coal in a central boiler plant, and heating the various buildings from one source, employing for this purpose as far as possible the exhaust steam from electric generating sets. The buildings which will ultimately be served have a total volume of about 7,570,000 cu. ft.; they contain 81,000 sq. ft. of direct radiation heating surface, need 185,000 cu. ft. of warmed air per minute for ventilation, and require as a maximum about 475 kw. for light and power. The greatest demand for steam for heating and ventilation for all the buildings in cold weather would be about 30,000 lbs. per hour.

The station as at present working supplies current to 11 buildings, and heat to five; and the heating service will be extended to all the buildings as opportunity serves.

A brief discussion of the systems of heating and ventilation in general use in Canada for large buildings, and a description of the nature of the demand for steam and current for the University purposes, is followed by notes as to some of the problems arising in the design and construction of underground piping systems for steam and hot water.

The McGill power-house itself is not of an unusual type, its equipment including four water-tube boilers, three steam-electric generating sets, the necessary heaters and auxiliary machinery, and the ordinary apparatus for the switchboard and electric accessories.

The heat distribution to the buildings being largely by means of forced circulation hot water, as well as by steam, the heaters and circulating pumps are installed in the engine room, and are at present capable of supplying hot water to 60,000 sq. ft. of direct radiation heating surface. Means are provided for obtaining a record of the heat delivered to the heating systems of the various buildings.

The electric distribution is by underground cables throughout, the cables as well as the heat distributing pipes being carried partly in tunnel and partly in conduit. Secondary heaters have been installed in two of the buildings, in order to avoid the expense of renewing their existing heating pipes and radiators.

The paper closes with a description of the methods of operation adopted, and the systems of temperature regulation employed, together with some notes as to working costs.

At the Students Meeting held at The Institution on the 19th, Mr. J. F. C. Snell, M.Inst.C.E. in the chair, Mr. G. Ingram, Stud. Inst.C.E., read his paper on "The Turbo-Blower and Turbo-Compressor." The author outlined the development, and theory underlying the design, and discussed at some length the most suitable means of driving these machines as used for blast-furnaces and mines. The paper was illustrated by numerous slide-diagrams showing details of construction and results of tests. The discussion was opened by Mr. J. E. Burkhardt and continued by Messrs. T. J. Taplin, T. F. Hay, and H. V. Hutt.

* Abstract of a paper read at the ordinary meeting of the Institution of Civil Engineers, on January 30.

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ECONOMIC GENERATION.

The Plant Extension Problem and Mr. J. E. Edgcome's Solution.

The problem which is always before small communities contemplating the creation of new, or the extension of existing electricity works, is that of the most economical system to adopt. On this matter there is much helpful material in a report which has just been presented to the Town Council of Kingston-on-Thames by the Borough Electrical Engineer, Mr. J. E. Edgcome, M.I.Mech.E., M.I.E.E.

Mr. Edgcome had reported to the Lighting Committee that so rapid had been the growth of the demand for current that there was only the small margin of 128 kw. between the present maximum demand of 672 kw. and the full capacity of the existing plant. As this margin is less than the full output of either of the three largest alternating current sets installed, in the event of one of these sets being disabled, even temporarily, the remainder of the generating plant would be overloaded to the extent of 12% in order to maintain the supply at its declared standard voltage. In view of the increasing demand for current he urged that by next winter the greater part if not the whole of the margin of 128 units per hour would have been taken up, and he added that he did not feel justified in advising the working of the station without sufficient spare plant.

The necessity for an extension of the plant having thus been made patent, the first question to arise was with regard to the system to be adopted, and to investigate thoroughly this portion of the problem some of the members of the Lighting Committee accompanied the Electrical Engineer on a tour of investigation. They visited the Electricity Works at Leatherhead, Windsor, Slough, and Maidenhead, and the following private works, viz., Messrs. Hoffman's at Chelmsford, Messrs. Ross & Company at Clapham Common, Messrs. Johnson's Cement Works at Greenhithe, Messrs. Williams & Robinson at Rugby, and Messrs. Mirrless, Bickerton & Day at Stockport. In Germany Diesel oil engines were inspected at Berlin, Tegel, Halle, Nuremberg and Augsberg, and in Belgium at Ghent.

In dealing with the results of this exhaustive inquiry, Mr. Edgcome discusses at the outset the respective merits of steam, gas and oil as the generating power. The present system of generation by steam plant, he says, is so costly for fuel that it cannot be recommended for the necessary extension of generating plant. The cost of generation by producer plant and gas engines is much lower under present working conditions than is the case with steam plant, but somewhat more costly than with Diesel engines; the capital cost per kilowatt installed is higher than with the latter type of plant; more floor space, and hence more buildings and foundations are necessary on account of the producer plant being required as well as the engines and generators; more labour is required to look after these combined plants than is the case with the self-contained Diesel plants; and the overhaul and repair is more costly, especially in respect to the producer portion of the plant. Diesel engines are especially suited to the Kingston conditions of working on account of their high efficiency at low loads, and owing to the long hours during which the plant runs on light loads, this is a particularly desirable feature in the case of this undertaking. The all-round fuel costs of Diesel engines are lower than those of any other type of plant in use; their cost for repairs is small; they are self-contained; they are very reliable and free from risk of breakdown. The horizontal type of Diesel engines possesses many advantages over the vertical type. Owing to its design and the manner in which it is distributed over its foundations, it is less likely to set up vibrations; also owing to its design it is more accessible in working as well as for overhaul and repair; the system of eccentrics and roller levers renders it much quieter in working than is the case with the system of cams in use with the vertical type; it is considerably cheaper in first cost; the slow speed of the horizontal engines recommended is a particularly satisfactory feature as tending to long life and low repair costs.

Mr. Edgcome gives some interesting points with regard to the conditions and method of installation:

> In connection with the purchase of new plant, by far the most important factor is the question of parallel running, and each of the firms that have quoted have been specifically asked to give an absolute guarantee that the generating sets for which they are tendering will run in parallel with each other, and also with the steam alternators at present installed at the station, and when the order for the machinery is placed, a penalty clause should be inserted in the agreement, giving the Corporation full power in respect to this question of parallel running, which is of such vital importance to the working of the station. The question of a guaranteed date of delivery and erection of the plant, ready for running, is also of considerable importance, in order that the new machinery may be working in time for the winter load of 1912.
>
> In order to take full advantage of the saving in cost of generation to be derived from Diesel oil engines, it will be necessary to shut down the steam plant for as long a period as possible, and it is for this reason that I advise the installation of two sets of comparatively small size, instead of one set of from 500 to 550 kw. The steam plant (boilers, engines, condensers and pumps, steam blow off and drain pipes, separators and steam traps) would be shut down at midnight and not brought into use again until, say, one hour before the load on the following day, consequently we should save the very considerable losses due to keeping a boiler under steam at light loads during the day and during the night (after the peak), including the heavy losses from radiation in the extensive range of steam pipes required for working the present plant.
>
> If the steam plant were shut down, it would take at least an hour to put it again into commission, so that it would be necessary to instal the second Diesel engine as a stand-by to the Diesel engine which would be running throughout the day and night, as if one Diesel engine only were installed, in the event of its breakdown when supplying current to the mains, a considerable time would have to elapse before the supply could be restored, whereas with a second Diesel set, this could be run up and put on circuit within from 1 to 2 min. The demand on our station is comparatively small throughout the day until dusk, and during the night after midnight, and this load would be dealt with by one Diesel engine running continuously throughout the day and night; towards dusk, as the load increased, the second Diesel engine would be put to work in conjunction with the Diesel engine already at work, and together they would take up the increased load to their full capacity, the extra load on the peak being dealt with by the steam plant. In the event of one of the Diesel engines being adrift for overhaul or repair, it would then be necessary to keep a boiler with steam up as a stand-by, but the general experience of those engineers who have run Diesel engines is that, when of satisfactory design and manufacture, they are particularly free from liability to breakdown and do not require frequent overhaul.

Mr. Edgcome goes on to give some important tables indicating the comparative cost of working in respect of the three possible methods of extending the plant. He shows that the capital cost of an extension of the existing steam plant to provide a further 200 kw., equal to an extension of 25% on the present capacity of the central station would be £3,320, involving an annual payment of capital and interest amounting to £280 18s. 8d. The capital cost of producer gas plant, gas engines and alternators, with the necessary extensions of the buildings, etc., would be £15,601, which would involve an annual payment for principal and interest of £1,311 4s. 5d., and would increase the present capacity of the station by 540 kw. or 67·5%. The cost of the oil plant as recommended by the committee is £13,500, involving an annual payment for principal and interest amounting to £1,132 11s. 4d., and increasing the capacity of the station by 540 kw. or 67·5%, the same as in the case of the gas plant. Another table shows the comparative cost of the generation of 1,010,000 units for the year 1911–1912, if by steam only or if by the proposed combination of steam and oil. Assuming that it was decided to extend the existing steam plant, the total cost of generation would be £5,253 13s. 1d.; but by the combined method now proposed, with steam in use only for the peak load, the total cost of generation would be £4,122 7s. 8d., or a saving of £1,131 5s. 5d. A further table on the same basis for the following year, when an increase of 110,000 units is expected, shows that the saving in generation would be £1,293 17s. 8d. Mr. Edgcome adds that under the new combined scheme there will be a saving of £240 a year in labour, as the staff could be reduced.

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Technical Problems and their Solution.

QUESTIONS AND ANSWERS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways, and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for the next best, but in the case of two replies adjudged to be of equal merit, these two sums may be added together and divided. Replies should reach the office within seven days of the appearance of the questions.

QUESTIONS.

Problem No. 1271.—Explain—with theoretical justification—a method of measuring fault resistances, applicable to 3-phase or 2-phase 3-wire networks. Simplicity is important.—" QUERIST."

Problem No. 1272.—On a three-phase circuit of shaft cables there are two pumps; one a turbine the other a three-throw. Starting up the three-throw causes a wattmeter coupled to one phase (balanced load) to revolve in its correct direction. Starting the turbine one now causes the disc to slow down, stop, and revolve in the opposite direction. Turbine works at half normal head. Pressure coil of wattmeter is connected to a potential transformer phase to neutral.—" P. F."

Problem No. 1273.—A revolving-field alternator with direct-coupled exciter, driven by a direct-coupled steam engine is to supply a 90 b.h.p. 6-pole constant speed induction motor; the system being three-phase, 750 volts, 40 cycles. As the motor would start only twice a day, it is proposed to use a squirrel-cage motor connecting it to the alternator through a protective device, without any special starting apparatus; the motor to be started by running up the generating set. The alternator has average characteristics and the motor would have:—Speed 783 r.p.m., efficiency 92% and power factor 93% at full load. No-load current 12 amps, and stand-still current 302 amps. (at a power factor of 23·4%) per phase. Ratio of transformation 8·6. Stator star connected; resistance hot ·182 ohms per phase. Show the relation between torque of the motor and voltage, current, frequency, and power factor at starting; also state any objections to the scheme.—" SQUIRREL-CAGE."

Problem No. 1274.—A potentiometer resistance is required to have 50 steps and an ohmic resistance of 400. It must be stepped out in such a way that the shunt field rises in equal increments of currents, while the difference in the potential drop between the first and second step and that of the two last must not be excessive. The line voltage is 440, resistance of shunt say 400 ohms. Shunt current 1·1 to 0 amperes.

ANSWERS.

Problem No. 1270.—When using a universal shunt in conjunction with a galvanometer it is best to have the total resistance of the universal shunt not greatly differing from that of the galvanometer, for if the resistances of galvanometer and shunt are disproportionate a loss of sensitiveness occurs. Explain the reason for this.—" BICKNOLLER".

Further reply to No. 1270 (*awarded* 5*s.*).—When considering this question a short review of the pros and cons of the universal shunt may help to make matters clearer. The figure is a diagrammatic sketch showing the connections of such a shunt.

Now if the total resistance of the universal shunt is equal to the resistance of the galvanometer, we can never get more than one half the main current through the instrument.

Let g = resistance of galvanometer,
r = total resistance of shunt,
a = portion of r in circuit with the galvanometer
(r—a) = portion of r in parallel with (g + a),
C = main current,
C_g = current in galvanometer.

Then from the law of shunts we have:—

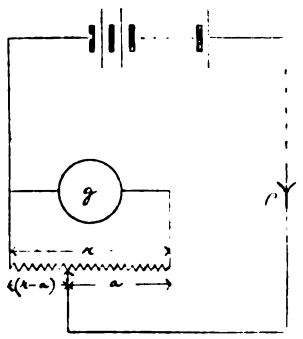
$$\frac{C}{C_g} = \frac{\frac{1}{g+a} + \frac{1}{r-a}}{\frac{1}{g+a}} = \frac{r-a+g+a}{(g+a)(r-a)} \times \frac{g+a}{1} = \frac{r+g}{r-a}$$

$$\therefore C_g = \frac{r-a}{r+g} C.$$

Therefore when whole of r is in parallel with g, and r = g, we have

$$C_g = \frac{C}{2}$$

That is, the current in galvanometer can never exceed one half that in the main circuit when total resistance of the universal shunt is equal to the resistance of the galvanometer.



Note here a peculiar property of the universal shunt; when (r — a) = a, then current in galvanometer is reduced in a similar proportion. Current in galvanometer will then be one half the value it was previously, viz., $\frac{C}{4}$ And so for other ratios.

There are tests when the main current is so small that the galvanometer has to be used without a shunt in order to get a workable reading.

Although it has been claimed that any universal shunt will do with any galvanometer, in practice r should be several times g; for accurate readings the resistance of the shunt should be infinitely great when compared with the resistance of the galvanometer. The designers suggest a ratio of 10 : 1; in that case the current in galvanometer would be $\frac{10}{11}$ of the main current.—" M. M."

Further Reply to No. 1270 (*awarded* 5*s.*).—The sensitiveness of a galvanometer is a measure of the deflection obtained when a current of known strength passes through the instrument, and one galvanometer is said to possess greater sensitiveness than another when, with equal currents passing through them, a greater deflection is produced in the first than in the second. The effects of shunting a galvanometer and of varying the ratio of the resistances of the shunt and galvanometer upon the sensitiveness of the instrument can be studied mathematically thus:—

Let g and s = resistances of galvanometer and shunt resp.
C and Cg = main and galvanometer currents resp.

Then $Cg = C \frac{s}{g+s}$

Now the following relation for a tangent galvanometer is found in any book on Electricity.

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$$Cg = \frac{a\,H}{2\,\pi\,n}\tan\theta$$

or for a moving coil instrument $Cg = \frac{T\tan\theta}{n\,A\,H}$

For any one type, the inside and outside dimensions of the coils are limited by such considerations as size and weight, so that we can assume that a and A in the above equations are constant for any definite type of the tangent and moving coil instruments respectively.

Hence $\tan\theta \propto$ number of turns $\times$ Cg.

Now the number of turns can be increased by decreasing the area of the wire in the inverse ratio, and since the resistance is proportional to the quotient $\frac{\text{number of turns}}{\text{section of wire}}$

$\therefore g \propto n^2$

But $\tan\theta \propto n\,Cg$, *i.e.*, $\tan\theta = Kn\,Cg$ where K is a constant.

$$\therefore \tan\theta = K\sqrt{g}\,C\,\frac{s}{g+s}$$

Now supposing that we are working with a constant shunt.

$$\text{Then } \frac{d(\tan\theta)}{dg} = KCs\left\{\frac{\frac{1}{(g+s)\,2\sqrt{g}} - \sqrt{g}}{(g+s)^2}\right\}$$

$$= KCs\left(\frac{s-g}{2\sqrt{g}\,(g+s)^2}\right)$$

$\therefore \tan\theta$ is maximum when $s - g = 0$.

Hence the maximum deflection is obtained when the resistances of the shunt and galvanometer are equal.

Next suppose the galvanometer resistance constant.

$$\text{Then } \frac{d(\tan\theta)}{dg} = K\sqrt{g}\,C\left(\frac{g}{(g+s)^2}\right)$$

$\therefore \tan\theta$ is maximum when $g + s$ = infinity.

But g is a known finite quantity, hence the maximum deflection is obtained when the shunt resistance is made infinite, that is when the galvanometer is not shunted at all. The last result is really obvious at first sight, since if we increase the shunt resistance, a greater proportion of the current is compelled to flow through the galvanometer. and therefore we obtain an increased deflection, but the full mathematical proof has been given in order to show the difference between the case of having a constant shunt and that of having a constant galvanometer resistance.

It is evident that "Bicknoller" has got confused between these two cases; his is that in which the resistance of the galvanometer is constant, and hence he will obtain the maximum sensitiveness by making the total shunt resistance as large as will be convenient for him.—E.H.

THE SILENT KNIGHT ENGINE*

By J. O. Ruscoe.

For some time past, engineers of various nationalities have experimented with internal combustion engines with a view to produce a reliable and efficient engine without the use of poppet valves.

The very nature of the function of a cam makes smoothness impossible, for the following reason.

In order to ensure the seating of a poppet valve, there must always be a clearance between the valve stem and the tappet. As the valve springs are comparatively strong, it means a hammer blow every time the valve is lifted. Before producing the Silent Knight engine as we know it to-day Mr. Knight carried out a number of experiments with various slide valve designs.

He first considered a plan of opening and closing ports at the top of the cylinder by means of an inverted piston. This piston was reciprocated in the top of the cylinder by means of a rocking lever and suitable valve gear.

Sliding cut off were used on either side of the cylinder to time the proper opening and closing of the ports.

The rocking lever which operates the inverted piston must of necessity be very strong to withstand the full force of the explosion. In time, the strain put upon this mechanism would tend to cause it to become noisy and inefficient.

This idea was discarded in favour of an engine working with a reciprocating cylinder, suitable ports being cut in the walls to time the opening and closing of the valves. The gearing necessary to impart the correct motion to the reciprocating cylinder, had, however, of necessity, to be very complicated. Also, the cylinder, being movable, could not easily be connected to the various pipes necessary for the gas exit and entrance, and the circulating water pipes. These constituted the two drawbacks to the engine.

Although engines of this type were manufactured, and are still running in America to-day, they are totally different in design to those manufactured by the English Daimler Company at the present time.

The reciprocating cylinder has been replaced by two reciprocating sleeves, working within an outer cylinder or shell. The two sleeves are telescoped, and the piston works within the inner sleeve. Inlet and exhaust ports are cut on opposite sides of the cylinder, the ports penetrating the outer shell and both sleeves. The sleeves are operated by means of eccentrics mounted on a half-time shaft. The inverted piston which enters the sleeves is stationary. It serves the purpose of covering the ports for the compression and working strokes. This inverted piston or cylinder head is water-cooled throughout, and, therefore, the ports in the sleeves are never exposed to the high initial temperature of the explosion. This prevents the ports from becoming burnt.

The combustion chamber is more or less spherical in shape. To this, and the position of the sparking plug, the great flexibility of the engine is attributed.

The R.A.C. engine test, which was carried out in 1910, proves the fact that the engine is absolutely reliable under very severe conditions.

The test consisted of:

(i.) Five days bench test under full load.

(iii.) 2,000 miles run in a standard touring car on Brooklands track (average speed 40 m.p.h.).

(iv.) Five hours bench test.

The test was carried out at the Daimler Works under the supervision of judges appointed by the Royal Automobile Club. None of the vital parts of the engine were disturbed until the whole test was completed.

When the engines were finally dismantled no appreciable wear was noticeable on any of the working surfaces.

* Abstract of a paper read before the Northampton Institute Engineering Society, with Mr. E. B. Ware in the chair, at 5.45 p.m., on January 26, 1912

ELECTRICAL ENTERPRISE IN JAPAN.

The British Vice-Consul at Osaka, in reporting that a Japanese joint stock company has recently been formed under the name of the Osaka Denki Seizo Kabushiki Kaisha (Osaka Electrical Machinery Manufacturing Company, Ltd.), for the manufacture of dynamos and other electrical machinery, states that the demand for such goods of every description is a constantly increasing one, but he points out that considerable progress has been made of late years in the manufacture of electrical machinery in Japan, and that Japanese manufacturers will have the advantage of considerable tariff protection.

According to a Japanese official announcement, the number of electrical works in Japan, and the capital invested therein at the end of 1910, were as follows:—

	No.	Nominal Capital.	Paid-up Capital.
		Yen.	Yen.
Electric light and power companies	186	199,348,055	127,998,960
Electric railway companies ..	15	25,110,000	14,927,500
Electric railway and power companies	25	130,721,678	99,353,239
Private installations	697	—	—
Government installations ..	93	—	—

The above-mentioned companies represent a total power of 472,205 kw. In addition to the foregoing it appears that 168 companies have now obtained official sanction to generate a further 381,232 kw. The yen is equivalent to 2s. 0½d.

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Electrical Progress at Home and Abroad.

UNITED KINGDOM.

Lighting, Power, Telegraph, Telephone, and General Business Notes.

ALLOA.—The Provost, Magistrates, and Town Council made an official inspection of the electricity station which has recently been erected and equipped in connection with the Corporation Gas Works. The current had previously been supplied in bulk to the Town Council by the British Electric Plant Company, but the experiment was not regarded as the most satisfactory or economical, and some time ago an amicable arrangement was arrived at between the company and the Council whereby the latter took over the manufacture as well as the distribution of the current. The visitors were accompanied by Mr. W. A. Ker, consulting engineer, Glasgow, and Mr. W. Tulloch, electricity manager. The station consists of a large open-roofed building 120 ft. long by 29 ft. broad, and contains three powerful gas engines of the most improved types and design, the flywheels of each weighing something like 14 tons—three slow speed dynamos of the continuous current type, wire balancers, boosters, etc. The visitors expressed much satisfaction with the general arrangements and the ample provision made for the supply of electricity to the town.

BRISTOL.—In view of the unsatisfactory lighting of Stapleton Workhouse, the Guardians have resolved to substitute electricity for gas. The House Committee reported that whereas gas cost from £325 to £350 per annum, the electric light at the Asylum cost only £235. They found from their inquiries that the Workhouse could be lighted by electricity at a much lower cost than was being paid for gas with all the advantages of better illuminating power, greater cleanliness and convenience, and therefore unanimously recommended its substitution for gas. The report was adopted.

HULL.—At a meeting of the Electricity Committee the Borough Electrical Engineer presented the estimates for the year ending March 31, 1913. The total estimated expenditure is £68,034, against £61,558 for last year. Coal and fuel show an increase from £9,444 to £12,015. Interest on loans absorb £12,661, and contributions to sinking fund, £14,161 ; £2,000 is set aside for mains, special renewal account, and £1,000 for dynamos, special renewal account. The estimated income is £69,088, against £63,421 for last year, and leaving an estimated balance of £1,054 against a balance of £1,863 for last year. By sale of electricity per meters, the amount of income is estimated to be £65,110. Other items in the income include £1,640 for rental of meters, £748 for public lighting, and £790 for special power.

TINTAGEL.—At a well-attended townsmeeting it was unanimously resolved to instal electricity for lighting purposes, and a provisional board was formed to carry the project into execution. Mr. Steele, representing Messrs. J. and W. Purves, of Exeter, explained that the scheme would cost £1,300 to £1,400 for the first two years, and after that another £500 might be required. He estimated that there would be about 600 lights by the end of the first year. He recommended overhead mains, as underground mains cost so much more. The cost per lamp would be from 9s. to 10s. each, and the upkeep 6d. per unit. It was not proposed to put any of the cost on the rates. It would take about nine weeks to complete the work, and he anticipated that by that time they would have 60 lights, while others would follow. The average cost would be about 5s. per year per lamp ; in hotels a little more. He recommended £1 shares with holders of from three to five shares each, and he estimated a profit of from 4 to 5%.

TUNBRIDGE WELLS.—Mr. J. W. Beauchamp, M.I.E.E., presided at the eighth annual dinner in connection with the Corporation Electricity Works, among the large company present being Alderman Carpenter, Councillors Brown, Edwards, and Dennis, and Mr. Horace Boot, the Consulting Engineer. Mr. Boot, on giving the toast of the Lighting Committee, said the town possessed one of the most up-to-date works in the country and they had made the undertaking a complete success. Alderman Carpenter, in responding, laid the credit of this success to the untiring energies of Mr. Beauchamp.

TRACTION NOTES.

BRIGHTON.—The poll of ratepayers in connection with the promotion of a Bill by the Corporation for constructing a system of railless traction resulted in a majority of 3,260 in favour of the project. Out of 20,250 burgesses only 7,892 recorded their votes, but there is no doubt that the general feeling is largely in favour of the project.

LEICESTER.—In the course of a lecture under the auspices of the Leicester and District Workers' Educational Association, Mr. E. George Mawbey, Borough Engineer and Surveyor, said that one of the works of greatest magnitude undertaken by the Corporation was the designing and carrying out of the electric traction scheme. There are about 20 miles of route, and 140 cars. The Tramway power station had not only turned out a practical and economical success for electric traction, but it had now been adopted and extended to meet the long-felt want of a supply of power for industrial purposes. It will be appreciated that the track is by no means the least important section of the work. Most of the track had now been in work for nearly eight years, and yet the renewals had been comparatively small, and confined mostly to the special track work and curves, which must necessarily receive the greatest amount of wear; whilst there were other towns where a very large proportion of the track has had to be relaid in a much shorter period. The total capital expenditure on tramway works, equipments, and cars, etc., had amounted to something like £600,000. The total capital outlay on various kinds of works which had been carried out by his departments during the last 22 years including the tramway scheme, had amounted to over two millions sterling.

MANSFIELD.—A tramcar mishap at Skerry Hill, where a car suddenly began to run backwards down hill, caused considerable alarm but no serious injury. Mr. Walker, the Tramway Manager, reports that the car had got within 10 yards of the top of the hill, when the fuse blew out, and the car commenced to run backwards. The passengers got excited, and rushing to the driver's end, interfered with him. He stuck to the brake, and eventually pulled up the car before it reached the bottom of the hill. If the men had kept their places he would have got the car very soon pulled up, because the brakes were in perfect order. The car did not get out of hand, and the trolley pole never left the wire, although the car was travelling backwards. Mr. Walker blamed to a large extent the number of men who crowded on to the car both back and front.

SHEFFIELD.—The "Sheffield Independent" announces that Mr. A. M. Rockhills, of Brincliffe, Sheffield, has patented an important improvement in connection with electric traction. In railway and tramway slot-conduits junctions of the type in which a single switch tongue is pivotally mounted below the V-shaped part of the junction, the tongue operating devices at opposite side of the conduit slot are connected through a rigid yoke having a lost-motion connection with the track-point tongues. The conduit tongue is operated by the pushers, carried by the yoke operated from the hand-lever against the action of the spring through a rod. The yoke moves idly with respect to the tongues for the first part of its movement in either direction as determined by the position of the nuts or collars. As a safeguard, the pusher rods are positively operated during the first of the movement through pawls which are gradually withdrawn by the cams, the tongues

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then being sufficiently free to permit trailing through. The yoke may have rollers for running on the supports and the spring may be carried by a separate rod. In a modification, the point tongues are brought back to their original position by means of springs, and the pusher rods are rigidly connected to the yoke.

CHESHIRE NOTES.

Harnessing the Dee—Hydro-Electrical Project Discussed and Carried—A Rare and Profitable Enterprise.

The scheme of the Borough Electrical Engineer of Chester under which it is proposed to harness the Dee and construct a hydro-electric power station on the site of the historic Dee Mills was discussed last week at a meeting of the Town Council. A report was brought up from the Electricity Committee (which held a special meeting to go into the matter) in which it was recommended that the scheme described in the report of the Electrical Engineer dated May 26, 1911, and approved by Mr. A. C. Hurtzig in his report dated August 29 be adopted and that application be made to the Local Government Board for sanction to borrow £13,000 for the construction of such works (including £500 to be paid to the River Dee Fishery Board for their expenses in erecting a fish pass and other works); that the specifications and drawings be submitted to Mr. A. C. Hurtzig, C.E., for examination, at a fee of fifty guineas; that an agreement, provisional on the sanction of the Local Government Board, embodying the terms of agreement with the Dee Fishery Board as contained in the chairman's report be entered into; that an agreement, also provisional on the sanction of the Local Government Board, for access to the river as approved by the Dee Conservancy Board, be entered into with that Board.

The adoption of this report was moved by Alderman R. Cecil Davies, Chairman of the Electricity Committee, who pointed out that this was one of the most important schemes that had come before the Council in recent years, and it would, in his opinion, prove one of the most beneficial to the city. The scheme proposed to utilise the water power of the old Dee Mills for generating electricity, and for that purpose it was proposed to use three water turbines and three electrical generators. The works would not obstruct the view of the public more than the present dilapidated buildings of the mill. The roof of the works would be flat, and would be open to the public, and would be in harmony with the scheme of the old Dee Bridge and the city walls. It was estimated that 1,250,000 units would be generated, that the sale of electricity so generated would produce £5,000 a year at a cost of £1,500, yielding a surplus income of something like £3,000, and the committee would thus be enabled to pay the capital involved in four and a half years. The Committee, he added, had given full consideration to the boating on the river, the Water Company, the Fishery Board, and the Conservancy Board. The committee thought the arrangements they had made would be most satisfactory, not only for the Corporation but also for the Fishery Board. The Corporation had the advantage of the assurance that the water rights of the Old Snuff Mills would not be used, and the Fishery Board would obtain a fish pass at a very small cost, and such a fish pass had long been wanted, and it would prove of the greatest benefit to the fisheries. The Improvement Committee would receive £100 a year from the Electricity Committee in the shape of rent. The source of power it was proposed to harness was entirely a natural one, but the electrical machinery to be used was not of a novel character. It was, however, a unique thing in this country—viz., the application of machinery for dealing with a large volume of water of a tidal river. The works would have to be completed next winter or otherwise they would have to put down new plant at the electricity works, a loan of £9,050 for which had already been sanctioned by the Local Government Board.

Mr. John Owens, in seconding the adoption of the report, said there was nothing like the scheme in England, but there was in Ireland. Considering the unique circumstances surrounding the scheme, the Committee had asked Mr. Hurtzig whether he had any hesitation in recommending such scheme, and he replied that he had not the slightest. The power of the Dee Mills had been used for centuries by those mills, and they were going to take over the rights of three other mills, which would give them a capacity of 6,000 cubic feet per minute. At present the electricity plant was working at its maximum capacity at the top load, and it could be safely said they were running a great risk to their plant, and unless the present scheme was adopted another would have to be so that the extra demand for electricity could be met.

Mr. Arthur Wall moved that the matter be deferred until the refuse destructor question had been settled, and also the question of the sewerage works, on which £60,000 was to be spent in a year or two. Mr. E. Owen Roberts seconded.

Mr. F. H. Brown was also for a policy of delay, one of his reasons being the possibility of interference with the water supply, on which subject he suggested a consultation between the Corporation Engineer and the Waterworks Company's engineer. His own personal view of the matter was that the Council would be very much safer if they followed well-known lines and developed their steam plant either in connection with their electricity works or in connection with the dust destructor. He estimated that the scheme would involve the Waterworks Company in a great cost, probably of £10,000, and that cost would have to be added to the scheme, which would have to be paid out of the rates of the city.

Alderman W. H. Churton very speedily demolished Mr. Brown's argument, pointing out that a few minutes' study of the scheme would convince anyone that they were not robbing the river of its water, but only availing themselves of its force as it passed over the weir. They were not going to utilise any more water than the Dee Mills had used, and were not proposing to raise the weir, or bank up the river, or take any other step that would lessen the supply of water by a single pint. The Alderman added that Mr. Brown had suggested that the Waterworks Company objected to the scheme, but as a matter of fact that company had never indicated the slightest opposition to the project. Had they done so their representations would have been received with every courtesy and considered with scrupulous care.

The amendment to defer the scheme was in the end defeated by 27 votes to 8, and a second amendment to refer it back was lost by 21 to 14. The scheme was then adopted and an application for sanction to the loan required having since been made to the Local Government Board, an inquiry will be held in due course.

GERMAN NOTES.

Electric Tramway Reports — Household Refuse as Fuel—Company Affairs.

The city of Hamburg is interesting itself in a new company formed to take over the Altrahlstedt-Volksdorf-Wohldorf lines hitherto the absolute property of the Elektrizitatsgesellschaft Kopping, to the extent of 770,000 marks of ordinary shares. The Corporation is also about to invest rather more than a million sterling for extending the Waldorf line through Prussian territory. This sum includes the purchase of land. It is probable that the working of the Waldorf line will be taken over by the Hamburger Hochbahn A.G.

An important electric line, from the commercial point of view, is decided on to connect Werdau with Crimmitschau and the intervening industrial district.

The Austrian Government has at last granted the concession for the Austrian part of the Vienna-Pressburg electric railway to the A.E.G. The Hungarian part was confided to the Banz Elektrizitatsgesellschaft long ago.

The Dustbin and Electricity.

Dr. Deguisne, of Frankfort, publishes some remarks in the "Deutsche Bauzeitung" with respect to the economic aspects of household refuse from dustbins as a source of electric energy. He says that it produces from 1,500 to 2,500 W.E. per kilogram when used as fuel for working dynamo steam engines. If the yield falls much below the lower limit the refuse must be mixed with coal or coke to increase the calorific value. It is of great importance in refuse burning that the furnaces should be designed so as

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to produce the highest possible temperature. At any rate, the use of this refuse will not pay unless it is used on a very large scale. Statistics show that in towns of not less than 20,000 inhabitants, half a kg. of dustbin refuse is produced per head per day. Now each kg. gives one kg. of steam and 20 kg. of steam have to be used to produce one kw. hour. The rest of the calculation is easy. More than 2,000,000 kw. hours per annum are now developed in Frankfort, which has 400,000 inhabitants, from the heat developed in the destructors. These consist of six ranges each of four furnaces. These 24 furnaces heat six boilers, and drive two turbo-dynamos of 360 kw. each. The results have so far been satisfactory that two more ranges of furnaces, and two more boilers, will shortly be put in, so that a third dynamo can be driven. Each range of furnaces burns from 30 to 35 tons of refuse per 24 hours, each ton giving about 65 kw. hours.

Company Affairs.

The Compagnie Generale d'Electricite, Paris, made a profit 1910–11 of about 8 million francs. It has effected a union with the Compagnie Generale Radiotelegraphique and with the Compagnia Generale Italiana di Elettricita of Milan, both recently established concerns. It has also taken over a considerable part of the capital of 10 million pesetas, about £400,000, of the Energia Electrica de Catalona at Barcelona, founded in November, 1911. The dividend is 8%.

ELECTRICAL INSTALLATION AT THE NEW WHITEHALL CLUB.

The new Whitehall Club, Princes-street, Westminster, recently built to the plans of Mr. H. Chatfeild Clarke, F.R.I.B.A., is fitted throughout with electric light, the installation having been designed with a view to combining the highest possible illuminating efficiency with economy both in first cost and current consumption. The fittings employed are of simple yet ornamental character and have been carefully chosen to suit the style and purpose of the various rooms. The metal work of the fittings is finished throughout in real bronze colour, and the same remark applies to the switch and bell push plates, portable standards, etc. In the main entrance hall, use has been made of the well-known Holophane spherical fittings; these are of 16 in. diameter and carry one 100 c.p. metallic filament lamp. Similar fittings but of smaller size were selected for the staircase and landings. In the dining room, electroliers carrying six lamps each are used, with Holophane prismatic shades, giving in conjunction with frosted lamps a soft but adequate illuminating effect. The general lighting in the room is supplemented by a number of wall brackets designed to match the electroliers. The use of flexible cords in conjunction with electroliers and brackets for suspending the lamps from the metal arms has been entirely avoided. In the smoking room, electroliers of a lighter pattern, also carrying six lamps each and Holophane satin finished shades are used, while in the adjoining card-room each card table is lit by means of an ornamental three-cord counterweight pendant fitted with a moss-green silk shade. The billiard room, situated on the third floor, is fitted with specially-designed billiard table fittings carrying six high candle-power lamps, each lamp being placed under a moss-green silk shade lined with white cardboard, the lighting of the tables being most successful. The lighting of the steward's rooms and other administrative parts of the building is on standard lines and calls for no special comment. The building is also equipped with a complete arrangement of electric bells, and also a telephone installation enabling the members to communicate directly from any floor to the public exchange. The wiring work was carried out by Messrs. Foote & Milne, Ltd., of 66, Victoria-street, S.W., and consists of C.M.A. vulcanised rubber insulated conductors enclosed in solid drawn screwed steel conduits. The switch and fuse distribution boards of Messrs. Spagnoletti & Company's manufacture, and are of substantial design enclosed in cast-iron cases. The ornamental fittings were supplied by the General Electric Company, Ltd., and Messrs. Veritys, Ltd., respectively, the special billiard table fittings being designed by the first named. The installation includes a number of electric fans, sewage-pump motor, Waygood electric passenger lift from ground to third floor, and three electric goods lifts. The consulting engineer for the electrical work was Mr. Reginald J. Wallis-Jones, M.Inst.C.E., M.I.E.E., of 50, Queen Anne's Gate, Westminster.

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"Seagumite."

THE NEW SUBSTITUTE FOR VULCANITE, GUTTA PERCHA AND LEATHER.

Attention has already been directed in these columns to the remarkable chemical discovery by means of which, using as a basis the common seaweed to be found in such infinite abundance around our coasts, a new substance of great commercial importance can be manufactured, which is not only non-inflammable, but is damp-proof, and germ-proof, is unaffected by heat, cold, oils or exposure to weather, and possesses insulating properties of an exceptional character.

This new substance, to which the name of "Seagumite" has been given, is the result of many years of investigation and experiment. Many scientists have foreseen the enormous possibilities afforded by a practically unlimited supply of this raw material, available at an insignificant cost, could only some means be found of utilising its well-recognised properties in such chemical alliance with other substances as would give them tenacity and hardness. It was reserved for a well-known London chemist, after exhausting many lines of research to hit upon the process which has now brought "Seagumite" into being as a commercial product of supreme value in many highly important directions. Some of these may here be briefly enumerated.

As as substitute for vulcanite, the new material can be used for gearing, sparking plugs, switch handles, high pressure jointing, switch-boards and all similar insulating materials. A report of tests made at the Westminster Testing Laboratories shows that the material stood a test of 32,000 volts which proves its extreme value for all electrical purposes. These tests were three-fold, and demonstrated, it is claimed, that the material has beaten all compositions for electrical purposes up to the present day.

For steam-jointing and packing, tests have shown that "Seagumite" is of especial value, being especially adapted for standing the action of chemicals and acids, and can be used for high pressure steam joints, pumps, cups, packings, or for gas and cylinder joints. The jointing has been used in the plant of the National Gas Engine Company, Ltd., at the Crystal Palace, for nearly six months, standing constant heat and strain of over 300 lbs. per square inch with the utmost success.

It is equally well adapted for motor and carriage tyres and covers, and for these purposes experiments have demonstrated that it possesses a durability and resilience equal to that of any other substance, while its cost is approximately two-thirds less. At the same time, it has greater endurance when used for outside covers and treads, inasmuch as it is unaffected by extreme heat or cold, and water makes no impression upon it. Its extreme adaptability is indicated by the fact that it can also be used for hoods and linings of motor cars and carriages, for which purpose it can be manufactured in any colour and has all the appearance of leather of high quality. As a matter of fact, indeed, it is just as suitable as leather for boots and shoes and is not merely a substitute for leather but an article cheaper, more hygienic, and more durable, and is damp proof and non-inflammable. It is capable of being utilised in every thing which has hitherto demanded leather and at less than one half the price. Tests have been applied as to wear durability and comfort in the case of policemens' boots in which they have been worn for six to nine months in all kinds of weather and have given every satisfaction. Bags and every kind of portmanteau can also be made with the material.

It is also particularly suitable for the treating of belts and is produced at a quarter the price of ordinary leather belting. It possesses great tensile strength and durability, is non-slipping and is not affected by oils, chemicals or weather. For roofing also it possesses advantages peculiarly its own, since both the heat and the heavy rains of the tropics leave it unaffected.

There would, indeed, appear to be no end to the immense variety of uses to which "Seagumite" can be applied with complete success and the extraordinary cheapness with which it can be produced—in its various forms it can be sold at an average price of 1s. 6d. per lb.—should commend it at once to the serious attention of all manufacturers and engineers concerned in any of the industries referred to.

Mention has already been made of the tests to which this material was subjected at the Westminster Electrical Testing Laboratory. Summarising the results of five separate tests of seven different samples, Mr. Lancelot Wild, A.M.I.E.E., the chief electrical engineer, reported that "the insulation resistance of the samples through the material is extremely high after the material has once been immersed in water for twenty-four hours, being, in fact, of the order of 30,000,000 megohms per centimetre cube. The dielectric strength is extremely high, and is, in fact, much higher than is ever likely to be required in practice. The very great increase of insulation resistance after immersion in water," he added, "is quite abnormal, and is to us at present inexplicable."

In another direction tests were made by Mr. Norman Collins, of the Empire Engineering Company, Ltd., in the presence of Mr. Robert A. Briggs, representing Mr. Frank Matcham, the well-known architect, and of Mr. Joseph S. Birman, A.M.Inst. C.E. Mr. Norman Collins, in his report, says, "the material manufactured for covering floors was subjected to a pressure of 30 lbs. per square inch against a wood wheel having a surface speed of 3,500 ft. per minute, without any apparent wear. The same material was immersed in sulphuric acid without any deterioration. We find that the material is unbreakable, and moreover, that upon subjecting it to the fierce blast of a large gas blowpipe, beyond the surface becoming a little charred it was unaffected, and, therefore, in our opinion, admirably suitable for covering floors in public buildings. We also demonstrated the use of this material for electrical purposes, showing the ease of drilling, burning and polishing, and would call special attention to the fact that all turnings and cuttings can be remoulded, thereby showing great economy in use. We are trying this material for separators in electric storage batteries."

In yet another direction the material emerged with complete success. Dr. E. Howard Adye, M.A., Ph.D., F.R.P.S.E., reporting that the sample submitted to him for physical tests met his "entire confidence" in so far as thermal non-conductivity and immunity from fire are concerned. And he added: "My microscopical examinations and chemical and physical experiments prove that 'Cam-Vig.' is homogenous, and more closely textured than any kindred compositions extant. Thermal and electrical conductivity, practically nil. Inflammability, even under the influence of explosives and such violent compounds as naptha, benzol, spirits of wine, and the like, nought."

These tests, and many others which could be cited, are sufficient to show that if "Seagumite" is

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being put upon the market with a large degree of confidence, that confidence is amply justified by eminent practical testimony. The material is now being manufactured by a private company, The British Seagumite Company, Ltd., of 26, Shaftsbury-avenue, of which Lord Tenterden is chairman, and of which the other directors are Mr. W. J. Potter and Mr. Joseph Wiggins, and premises (which include three acres of land) have been taken at Woodham Ferris, in Essex, which are now being equipped with new plant and machinery capable of producing an average output of six tons of the material per week.

THE JUNIOR INSTITUTION OF ENGINEERS.

A party of members of this Institution, through the kind permission of Mr. G. E. Pingree, Managing Director, paid a visit recently to the works of the Western Electric Company at North Woolwich, and spent a most interesting and profitable time in being shown over the various departments, amongst which may be mentioned the milling department equipped with a large number of milling machines of various type; punch press department, containing presses of all kinds; the partially assembly department, where various intermediate operations are carried on; a fitter's shop, together with the repair department, under the charge of the factory engineer; the iron-working and tinsmiths' shops; a switchboard frame assembly room; an exceptionally well-equipped tool-making room, with its small drawing and inspection offices; drilling and full automatic machinery; condenser department, coil winding room; switchboard cabling department; interior of paper covering shop; impregnating tanks; motor driven hydraulic pumps; armouring machine; lead press shop; generating plant in power station; telephone cable stranding shop, with its huge 500 pair stranding machine, and condensing plant. The magnitude of the works impressed the visitors, who were lucky in seeing the various processes and machinery in operation, and their thanks were voiced by Mr. Walter T. Dunn, Chairman of the Institution, to which Mr. G. H. Nash, and Mr. Chas. Rice, replied, and the visit came to a conclusion. On the 12th inst., the Institution is holding a combined meeting with the Architectural Association, to hear and discuss a paper by Paul Waterhouse, M.A., F.R.I.B.A., on "Bridges," and on the 17th the Institution's annual dinner is to be held.

HYDRO-ELECTRIC POWER IN CANADA.

The Canadian Commission on the Conservation of Natural Resources has issued a report on the Water Powers of the Dominion which is the result of nearly two years work of investigation. The following estimate is given of the total water power developed in Canada in 1910:—Ontario, 532,266 h.p.; Quebec, 300,153 h.p.; Nova Scotia, 15,272 h.p.; New Brunswick, 9,765 h.p.; Prince Edward Island, 500 h.p.; Manitoba, 48,300 h.p.; Saskatchewan, 45 h.p.; Alberta, 7,300 h.p.; British Columbia, 100,920 h.p.; Yukon, 2,000 h.p.; total, 1,016,521 h.p. The total for the previous year was 486,887 h.p. Of the water power developed in 1910, 742,955 h.p. was used for the generation of electrical energy, and 158,051 h.p. in connection with the paper and pulp industries.

Diary.

FRIDAY, FEBRUARY 2.

BATTERSEA POLYTECHNIC.—Battersea Park-road. "Daylight and Artificial Lighting Compared," by Mr. J. S. Dow, 7.30 p.m.

SATURDAY, FEBRUARY 3.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—Annual Dance, Caxton Wall, Westminster.

FRIDAY, FEBRUARY 9.

BATTERSEA POLYTECHNIC. — Battersea Park-road. "Colour of Artificial Illuminants," by Mr. J. S. Dow, 7.30 p.m.

LONDON ELECTRIC RAILWAY.

The report for the half-year shows that gross receipts were £366,190, an increase of £13,295 while working expenses were £170,941, an increase of £3,973. After providing for interest and rents, and reserving £7,500 for contingencies and renewals, there remains a balance of £112,092 available for dividends, and the directors recommend a dividend at the rate of 4% per annum on the Four per cent Preference stock, and a dividend at the rate of 1% per annum on the Ordinary shares, leaving £2,452 to be carried forward. The following table gives a summary of comparative figures for the corresponding half-years of 1911 and 1910:—

	Half-year ended Dec. 31, 1911.	+ Inc. or — Dec.	Per Cent.
Gross revenue	£366,190	+ £13,295	+ 3·767
Working expenditure	170,941	+ 3,973	+ 2·380
Passenger receipts	342,451	+ 9,888	+ 2·973
Train mileage	2,741,309	— 73,326	—2·605
Car mileage	9,121,677	+ 484,928	+ 5·615

The traffic was adversely affected, owing to the weather conditions during the summer months and the dislocation of the whole of the railway traffic in London caused by the strike in August last. Contracts for the construction of the Charing Cross and Paddington extensions have been entered into, and the work is progressing satisfactorily. The moving stairways at Earl's Court Station was brought into use on October 4, and has proved a popular and convenient means of interchange between the Great Northern, Piccadilly and Brompton and Metropolitan District Railways at that point.

With regard to extensions the report states that powers are to be sought in this Session of Parliament to construct an extension of the Baker-street and Waterloo line from its present authorised terminus at Paddington Station to the Queen's Park Station of the London and North-Western Railway, at which point a physical junction will be made with the company's electrified line, so that a through service of trains can be run from Elephant and Castle to Watford. The company has made a provisional agreement with the London and North-Western Railway Company whereby that company will advance the money required for the construction and equipment of the extension railway, and also for the rolling stock required by the company for the through service to Watford. Powers are being sought by the Bill to amalgamate the Edgware and Hampstead Railway Company with the company, and to increase its capital powers for that purpose. The Edgware and Hampstead Railway, as at present authorised, extends from the terminus of the Charing Cross Euston and Hampstead line at Golder's Green to Edgware, a distance of approximately 4·67 miles. The railway, if built, will form an extension of the Charing Cross Euston and Hampstead Railway, and should act as a valuable feeder to that line.

The Bill also seeks power to instal escalators and to make subway connections at the Elephant and Castle Station, and to construct an additional exit at Oxford-circus Station. These facilities are necessitated by the increasing traffic. The additional capital sought by the Bill is £700,000, with the usual borrowing powers. A further Bill is to authorise the deviation of part of the Edgware and Hampstead Railway; to confer further powers on the Edgware and Hampstead Railway Company; and for other purposes. By this Bill power is sought by the Edgware and Hampstead Railway Company to enter into agreements with the London Electric Railway Company in reference to the construction of the Edgware and Hampstead and to the maintenance, working, use and management, etc., of the railways of the Edgware and Hampstead and London Electric Railways Companies.

LONDON UNITED TRAMWAYS.

The report for the past year shows that the gross receipts increased by £10,328 while working expenses decreased by £15,178, the increase in net revenue being £25,503 as compared with 1910. The number of passengers carried during the year was 62,547,128, an increase of 2,414,677 over the preceding year's figures. Including £814 brought in, and after payment of interest on Debenture Stock and loans for the year, and providing for income-tax, there remains a balance of £56,431, an increase of £25,617, as compared with the preceding year. The available revenue would have sufficed for a dividend distribution on the Preference shares, but the directors consider that in the company's best interests it is advisable for this year to continue to strengthen the reserves by appropriating the sum of £30,000. Of the remaining balance the directors propose to place £25,000 to reserve for renewals and contingencies (raising the same to £76,033) and to carry £1,431 forward. The report states that the undertaking has been well maintained and extensive improvements have been made to the permanent way during the year. The total cost of these improvements, including the balance of expenditure on improvements to the power-house commenced in the previous year amounted to £18,365, of which £16,265 has been charged to the reserve for renewals and contingencies.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1911-12.	1910-11.	Week.	Current year.	1911.	1910.	Ending	Total receipts.	Passengers carried.	Car miles run.	Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Jan. 24	1,411	1,188	+ 223	+ 3,114	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5· 3
Ayr Corporation	Aug. 12	550	572	— 22	—	8	8	—	—	—	—	—	—	—	—
Birkenhead Corporation	Jan. 28	1,020	965	+ 55	+ 1,830	24·089	24·089	Mar 31	56,713	12,544,501	1,207,761	1·089	11·13	2,315	6·74
Birmingham Corporation	Jan. 20	9,992	6,868	+ 3,124	+ 78,573	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Aug. 23	1,304	1,002	+ 302	+ 2,392	14·62	—	Mar. 25	58,367	10,310,965	1,041,021	1·27	12·60	3,915	5·36
Blackpool Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Jan. 27	244	211	+ 33	+ 53	—	—	Dec. 31	35,210	2,939,144	592,312	—	—	—	—
Bolton Corporation	Jan. 28	2,289	2,261	+ 28	+ 6 286	46	42	Mar. 31	121,707	27,018,149	2,641,292	1·08	11·05	2,897	6·58
Bournemouth Corporation	Jan. 24	1,434	1,250	+ 184	+ 549	30	21·95	,, 31	89,695	14,686,368	1,782,706	1·46	12·07	3,066	7·76
Bradford Corporation	Aug. 5	5 573	5,706	— 133	+ 8,201	100	54·81	—	—	—	—	—	—	—	—
Brighton Corporation	Jan. {28	755	740	+ 15	+ 2,530	9·5	—	,, 31	49,124	10,708,184	1,126,676	1·101	10·464	2,857	—
Bristol Tramway Company	Jan. 26	5,606	5,432	+ 174	+ 2,266	57	57	Dec. 31	308,615	47,454,560	5,914,718	—	—	—	—
Burnley Corporation	Jan. 27	1,200	1,256	+ 56	—	22	22	Mar. 31	65,295	12,911,113	1,263,118	1·21	12·41	6,067	7·89
Burton Corporation	Jan 28	252	229	+ 23	+ 662	10	6½	,, 31	15,368	3,131,172	432,911	1·07	7·75	1,416	6·41
Cardiff Corporation	Jan. 27	2,194	2,131	— 62	+ 7,806	17·35	17·35	,, 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Central London Railway	Jan. 27	5,220	5,323	+ 103	— 1,435	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,780	2·01	6·769	55,404	30·27a
City and South London Railway	Jan. 28	3,437	3,432	+ 5	— 508	7·26	7·26	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Jan. 25	419	417	+ 2	+ 83	9·89	9·89	Dec 31	25,497	5,704,071	899,173	1.07	6·80	2,578	—
Croydon Corporation	Jan. 19	1,580	1,476	+ 104	+ 5,280	11⅛	—	Mar. 31	85,806	19,476,576	2,269,500	1·057	9·07	4,428	—
Darwen Corporation	Dec. 29	—	—	—	—	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Jan. 20	188	161	+ 27	+ 1,465	7	7	,, 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Jan. 26	109	102	+ 7	+ 10	7	7	Dec 31	7,472	449,677	146,081	4·0	12·27	1,067	8·38
Dublin U.T.	Jan. 26	5,137	4,949	+ 187	— 1,370	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	July 19	1,238	1,210	+ 28	— 83	28	—	May 15	62,328	16,843,909	1,322,894	·87	11·30	—	7·28
East Ham Corporation	Jan. 27	1,007	931	+ 76	+ 2,792	15	14	Mar. 31	53,287	16,059,912	1,303,753	·78	9·81	3,750	7·57
Glasgow Corporation	Jan. 27	17,151	17,779	— 628	+ 37,627	196	195½	May 31	893,591	222,730,571	20,974,016	·96	10·22	4,706	5·75
Gloucester Corporation	—	—	—	—	—	15	—	—	—	—	—	—	—	—	—
Halifax Corporation	Sept. 5	2,186	1,954	+ 232	+ 5,375	37·171	37	Mar. 31	92,609	17,067,856	1,909, 97	1·30	11·64	2,456	—
Huddersfield Corporation	A g. 19	2.298	1,965	+ 300	+ 4,324	29	28½	,, 31	96,185	19,001,660	2,058,663	1·22	11·21	3,375	6·31
Hull Corporation	Jan. 27	2,956	2,753	+ 202	+ 7,089	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Sept. 2	545	526	+ 19	+ 5	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Jan. 24	119	110	+ 9	+ 133	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Jan. 24	1,134	1,162	— 28	+ 4	39	39	Dec. 31	68,689	13,755,329	2,272,765	—	—	—	—
Leeds Corporation	Sept. 9	7,689	7.174	+ 51	+ 12,730	108	108	Mar. 31	357,610	78,385,015	8,152,990	1·08	10·41	3,311	5·42
Leicester Corporation	Jan. 27	2,467	2,298	+ 169	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Jan. 20	11,103	10,470	+ 633	+ 2,674	116	109	Dec. 31	582,276	125,507,283	12,235,408	1·106	11·42	5,020	7·955
Liverpool Overhead Railway	Jan. 28	1,551	1,400	+ 151	+ 371	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Jan. 17	42,983	39,911	+ 3,072	+ 94,283	133⅜	133¼	Mar. 31	1,891,035	418,317 377	39,545,512	1·06	11·48	—	6·42
London Electric Railway	July —	60.847	58,978	+ 1,208	—	21·25	21·25	—	—	—	—	—	—	—	—
Lowestoft Corporation	Jan. 27	133	134	— 1	+ 47	3½	—	Sept. 30	10,896	2,377,316	329,958	1·07	7·9	2,179	6·82
Maidstone Corporation	Mar. 6	157	100	+ 7	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Jan. 27	15,356	15,010	+ 346	+ 36,169	183	183	Mar. 1	810,094	165,800,077	17,367,200	1·16	11·19	4,667	7·17
Metropolitan District Railway	Jan. 6	12,535	12.105	+ 430	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Jan. 28	17,339	17,126	+ 213	— 746	24½	24½	Dec. 31	718,089	102,849,458	—	1·48	—	—	—
Nelson Corporation	Jan. 27	144	134	+ 10	+ 1 567	2½	2½	Mar. 31	7,576	2,118,878	203,708	—	8·93	—	—
Newcastle-on-Tyne Corporation	Jan. 27	4,080	3,879	+ 202	+ 14,456	60½	59½	,, 31	206,130	45,335,207	4,437,639	1·09	11·15	3,421	—
Newport (Mon.) Corporation	Dec 30	726	787	— 61	+ 944	14½	14½	,, 31	35,146	8,452,562	895,238	·99	9·42	2,425	—
Oldham Corporation	Aug. 13	2,137	1,886	+ 227	+ 2,643	36½	35	,, 25	97,842	19,125,202	1,893,777	1·15	12·399	2,653	8·817
Portsmouth Corporation	April 29	1,788	1,783	+ 5	— 1,240	15½	28½	Mar. 31	102,978	23,053,717	2,291,767	1·10	10·15	—	—
Reading Corporation	April 27	570	556	+ 13	+ 171	13½	13½	,, 31	32,506	7,834,575	909,439	·96	8·28	4,183	4·98
Rochdale Corporation	Sept. 9	1,539	1,296	+ 243	+ 4,823	27	20·93	,, 31	63,000	11,360,871	1,402,532	1·31	10·774	—	—
Rotherham Corporation	Aug. 31	655	645	+ 10	+ 1,412	12	9·39	,, 31	33,313	6,960,178	722,393	—	11·06	—	—
Salford Corporation	S pt. 4	4,872	4,907	— 37	+ 6,056	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	April 23	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Jan. 28	6,566	6,128	+ 438	+ 18,431	40	40	Mar. 25	316,739	84,500,331	7,618,383	·900	9·978	4,144	—
Southampton Corporation	Aug. 16	1,471	1,281	+ 190	+ 3,372	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 2	980	1,253	— 273	+ 1,489	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Aug. 6	1,594	1,553	+ 41	+ 3,128	20	20	,, 31	58,889	14,561,672	1,451,906	·97	9·73	2,944	—
Swindon Corporation	Nov. 8	155	138	+ 17	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	—	—	—	—	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey Corporation	Jan. 6	1,111	953	+ 158	+ 5,921	12·68	12·45	Mar. 31	49,835	9,990,653	1,059,629	1·19	11·28	3,971	—
Warrington Corporation	Dec. 28	498	465	+ 33	+ 476	9⅞	9·656	,, 31	20,169	5,206,980	435,774	·915	10·939	2,064	6·291
West Ham Corporation	Mar 23	2,445	2,250	+ 195	—	27·8	27·8	Mar. 31	127,066	36,846,649	2,907,805	·801	10·21	4,518	7·22
Wolverhampton Corporation	Jan. 2	759	838	— 79	—	25	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6.509

a Train Miles. b Half-years' figures.

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Electrical Contractors' Section.

Contracts Open and Accepted, and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 129, Fleet Street, London, E.C.

CONTRACTS.

CITY AND COUNTY BOROUGH OF BELFAST.

ELECTRICITY DEPARTMENT.

STORES.

The Tramways and Electricity Committee invite Tenders for twelve months' supply (ending March 31, 1913) of the undermentioned materials :—

SECTION No. 1.
Sub-Section
1. Lubricator and Gauge Glasses.
2. Packings.
3. Oils.
4. Rubber Goods.
5. Bricks, Firebricks, and Fireclay.
6. Tools.
7. Incandescent Lamps.
8. Asbestos Goods.
9. Solder.

SECTION No. 2.
Sub-Section
1. Trolley Wire.
2. Overhead Line Material.
3. Galvanized Wire.

SECTION No. 3.
Vulcanized Bitumen Insulated Cable.

SECTION No. 4.
Sub-Section
1. Refined Trinidad Bitumen.
2. Bitite Strip, Prepared Tape and Rubber Tape for Joints.
3. Joint Box Compound.
4. Fuse Wires.
5. Wood Troughing.
6. Stoneware Troughing.
7. C.I. Street Box Frames and Covers.
8. Glazed Stoneware Conduits.
9. Cast Iron Pipes.
10. Lighting Feeder and Section Pillars.
11. Glazed Stoneware or Glass Cable Bridges.
12. Copper Cable Connectors.
13. Arc Lamp Carbons.

SECTION No. 5.
Sub-Section
1. Electricity Meters.
2. Electricity Maximum Demand Indicators.
3. Automatic Time Switches.
4. House Service Cut-outs.

Form of Tender for any of the five sections and further particulars may be obtained from Mr. T. W. Bloxam, City Electrical Engineer, East Bridge-street, Belfast, on payment of 10s. per Section, which will, after the Council or their Committee have come to a decision on the Tender received, be returned, to the Tenderer, provided he shall have sent in a bona fide Tender, and shall not have withdrawn the same.

The whole or any part of a Tender sent in may be accepted and Tenders shall be open for acceptance until May 1 next.

Tenders, endorsed "Tender for Stores, Electricity Department," to be lodged in my office not later than 10 a.m. on Monday, February 19, 1912.

A Tender, if sent by post, must be registered ; if delivered, an official receipt must be obtained for it ; otherwise the undersigned will not be responsible.

The Council do not bind themselves to accept the lowest or any Tender.

R. MEYER, Town Clerk.

BOROUGH OF STOCKTON-ON-TEES.

ANNUAL SUPPLIES.

The District Fund, Gas, and Electricity Committees of the Stockton-on-Tees Corporation invite Tenders for the several ARTICLES and STORES required by them for the year ending March 31, 1913. Forms of Tender, conditions of contract, and all information may be obtained of the Borough Surveyor, Gas Manager, and Electrical Engineer. Persons desirous of tendering should state the articles they desire to offer. Tenders, endorsed "Stores," and also marked for the particular Committee for which they are intended, on printed forms only, to be delivered to me not later than February 14, 1912. The lowest or any Tender not necessarily accepted, and no guarantee will be given as to quantity required.

(By Order) ARTHUR B. CROSBY,
Town Clerk.

Stockton-on-Tees. January 25, 1912.

CONTRACTS—*continued.*

BRISTOL DOCKS.

CABLES AND SWITCHBOARDS AND ELECTRIC LIGHTING, AVONMOUTH.

The Docks Committee of the Council of the City and County of Bristol are prepared to receive tenders for the supply and delivery, construction, testing and maintenance for 12 months after they shall have been taken into public use, of Cables, Switchboards, and Electric Arc and Incandescent Lighting at the Avonmouth Docks.

On and after Monday, January 29, 1912, copies of the Specification, Schedule, Form of Tender and Form of Contract and copies of the contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the Secretary of the Docks Committee, Docks Office, 19, Queen-square, Bristol, to whom all cheques must be made payable. The deposit of £5 will be returned to bona fide tenderers after receipt of a tender, accompanied by all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope endorsed "Tender for Cables and Lighting, West Wall and Cold Stores," and addressed to the Secretary of the Docks Committee, Docks Office, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Monday, the 19th day of February, 1912.

The Docks Committee of the Council of the City and County of Bristol do not bind themselves to accept the lowest or any Tender.

W. W. SQUIRE, Engineer.

Engineer's Office, Cumberland-road,
Bristol.
January 23, 1912.

CORPORATION OF BRISTOL.

ELECTRICITY DEPARTMENT.

The Electrical Committee will be glad to receive Tenders for a twelvemonth's supply of the following :—

(a) Arc lamps.
(b) Joint and Fuse Boxes.
(c) A.C. Meters.
(d) D.C. Mercury Type Ampere-hour Meters.

Copies of the Specification may be obtained of the undersigned on payment of a deposit of *Two Guineas for each section*, which will be returned on receipt of a bona-fide tender.

Sealed Tenders, addressed to the undersigned, to be delivered by 10 a.m. on Tuesday, February 20, 1912.

The lowest or any Tender will not necessarily be accepted.

H. FARADAY PROCTOR,
M.Inst.C.E., M.Inst.E.E.
Engineer and General Manager.

Electricity Department,
Exchange, Corn-street,
Bristol.

OSRAM-LAMPS

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CONTRACTS—*continued.*

METROPOLITAN BOROUGH OF POPLAR.

The Council of the Metropolitan Borough of Poplar are prepared to receive tenders for extensions to their existing E.H.T. and D.C. SWITCHBOARDS, at their Electricity Works, Glaucus-street, Bromley-by-Bow, London, E., and their Electricity Sub-stations situated in Millwall, London, E.

Specification and form of Tender may be obtained from Mr. J. Horace Bowden, Borough Electrical Engineer and Manager, Glaucus Street, Bromley-by-Bow, London, E., on payment of 5s., which will not be returned.

Sealed Tenders, addressed to the Town Clerk, Council Offices, High-street, Poplar, London, E., endorsed "Tenders for Switchgear," are to be delivered by 12 noon, on Friday morning, February 16, 1912.

The Council do not bind themselves to accept the lowest or any tender.

LEONARD POTTS,
Town Clerk.

APPOINTMENTS.

WANTED, a Charge Engineer for Newport Corporation Electricity Works. Applicants must have had thorough experience with H.T. single-phase and D.C. work; preference will be given to those having also had E.H.T. three-phase experience. Salary £2 per week, rising to £2 10s. None but fully qualified Central Station Engineers need apply. Applications, stating experience and age, also earliest date able to start duty must be sent to

H. COLLINGS BISHOP, M.I.E.E.,
Borough Electrical Engineer and Tramways Manager.
Town Hall,
Newport, Mon.

THE DUNDEE TOWN COUNCIL.

ELECTRICITY DEPARTMENT

Is prepared to dispose of FIVE TONS of old CABLE COPPER, and will be pleased to receive quotations for same. These to be sent in to the undersigned on or before Tuesday, the 6th February, 1912.

H. RICHARDSON,
General Manager.

Dudhope, Crescent-road,
Dundee, Feb. 1, 1912.

Contracts Open.

HOME.

BELFAST.—The Tramways and Electricity Department of the City and County Borough invite tenders for one automatic Coal Weighing Machine and Overhead Electrical Equipment Material. Particulars (£1 1s. each, returnable) from Mr. T. W. Bloxan, City Electrical Engineer, East Bridge-street. February 12.

BELFAST.—The Tramways and Electricity Committee of the City and County Borough invite tenders for 12 month's supply of stores as set out in Official Notice. Particulars from Mr. T. W. Bloxam, City Electrical Engineer, East Bridge-street. February 19.

BERMONDSEY.—The Borough Council invite tenders for the supply for one year from April 1 of arc lamp carbons and brushes, cable and jointing material, conduits, electricity meters, demand indicators and main fuses, engine oils, meter boards, street frames and covers and joint boxes. Particulars from the Borough Electrical Engineer. February 19.

BRISTOL.—The Electricity Department of the Corporation invite tenders for a twelvemonth's supply of (a) arc lamps, (b) joint and fuse boxes, (c) A.C. meters, (d) D.C. mercury type ampere hour. Particulars (£2 2s. each section, returnable) from Mr. H. Faraday Proctor, M.Inst.C.E., M.I.E.E. February 20. See Official Notice.

BRISTOL.—The Docks Committee of the City Council invite tenders for the supply and delivery, testing and maintenance for 12 months after they shall have been taken into public use, of Cables, Switchboards and Electric Arc and Incandescent Lighting at the Avonmouth Docks. Particulars (£5, returnable) from the Secretary of the Docks Committee, 19, Queen-square. February 19.

EPSOM.—The Urban District Council invite tenders for the supply and erection of one 200 kw. Diesel generator. Particulars (£2, returnable) from Mr. A. C. Gilling, Electrical Engineer. February 13.

EXETER.—The Visiting Committee of the Asylum invite tenders for the supply of (a) steel conduits and fittings; (b) vulcanised rubber cables; (c) distribution fuse boards, distribution switch and fuse boards. Particulars from the Clerk, 8, Southernhay West, Exeter. February 2.

HORNSEY.—The Town Council invite tenders for the supply of (a) Electricity Meters, (b) Cables, Cable Stores, etc., for the Electricity Works. Particulars (10s. 6d., returnable) from the Borough Electrical Engineer, Tottenham-lane. February 7.

LEEDS.—The Corporation invite tenders for the supply of 1,000 alternating current watt meters, to be delivered as required on or before June 30, 1913. Particulars from Mr. H. Dickenson, Manager, Electric Lighting Department, 1, Whitehall-road. February 14.

MANCHESTER.—The Tramways Committee of the City Corporation invite tenders for the supply of tramcar-type ampere-hour meters. Particulars from Mr. J. M. McElroy, General Manager, 55, Piccadilly. February 20.

ROCHDALE.—The Corporation invites tenders for the electric lighting of the Art Gallery. Particulars from Mr. P. W. Hathaway, A.R.I.B.A., Town Hall. February 6.

TUNBRIDGE WELLS.—The Town Council invite tenders for the supply and erection of switchgear at the generating station. Particulars from Mr. J. W. Beauchamp, Borough Electrical Engineer, Stanley-road. February 10.

WALLASEY.—The Corporation invite tenders for the supply and erection of one 500 kw. alternator and Diesel oil engine combined. Particulars from Mr. J. A. Crowther, Engineer and Manager, Electricity Works, Seaview-road, Liscard. February 12.

OVERSEAS.

CONSTANTINOPLE.—Tenders will be received at the "Ministère des Travaux Publics," Constantinople, up to February 20, for a concession for the supply of electric light and power to the town of Adalia, which has a population of some 30,000. The supply of power for telegraph and telephone installations and electric traction is excluded from the concession. Power is to be generated from waterfalls. Tenderers must supply proof of technical and financial competency, and a deposit of £T250 (£225) is required with each tender. Local representation is practically indispensable in the case of Turkish Government contracts. A list of British commission agents established in Constantinople may be obtained by British firms on application to the Commercial Intelligence Branch of the Board of Trade.

Tenders Accepted.

BINSLEY.—Turbine pump equipment at Binsley Colliery: The British Electric Plant Company, Ltd., £305.

BRIGHTON.—"Wotan" lamps for the complete street lighting scheme of the Corporation: Messrs. Siemens Bros. Dynamo Works, Ltd.

Messrs. Siemens Bros. Dynamo Works, Ltd., have obtained the contracts for the supply of "Tantalum" traction lamps to the following railway and steamship companies:—The Great Eastern Railway, The Aberdeen White Star Line, Messrs. Bullard, King & Company, The Natal Line, and also The Allan Line. They have also received a contract for supplying "Tantalum" traction lamps to the London County Council for use on their tramway cars; and for the supply of "Wotan" lamps for the complete street lighting scheme of Brighton Corporation.

Openings for Trade.

ARGENTINA.—The "Boletin Oficial" publishes a decree authorising the "Direccion General de Arquitectura" to invite tenders for supplying electric light and power to the District Colonial Asylums at Oliva (Province of Cordoba) and Retardados en Torres (Province of Buenos Aires). The total cost is estimated at about £21,000.

AUSTRALIA.—With reference to the proposed expenditure towards the establishment of the Australian Federal capital, the Melbourne "Age" states that the new works to be begun when contracts have been placed are the power plant of 600 kilowatts at Molonglo River for generating power for brick works, dam construction and tunnelling, and for supplying water and lighting for the workmen's camps; and works for a permanent water supply, involving a rising main from the Cotter river and pipe head and service reservoirs. The amended estimates for the various works, most of them to be spread over two or three years, are:—Power plant and accessories, £20,000; brick works, buildings, etc., £30,000; weir, Cotter river, £30,000; rising main and pumping stations, £140,000 Murrumbidgee bridge, with pump suction tunnel, £40,000; railway to Queanbeyan, £25,000; roads, £10,000; Acton and afforestation area, £13,000; joinery timbers, £5,000.

AUSTRO-HUNGARY.—The municipal authorities of Pécs (Hungary) have authorised a call for tenders for the erection of a central electric generating station.

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BULGARIA.—The Bulgarian Government have brought in a Bill providing credits for the following harbour works:—Silistria 1,000,000 frs., Bourgas extension of harbour, 3,000,000 frs., and 500,000 frs. for electric light and power; Varna 1,350,000 frs. to purchase a floating dock, 300,000 frs. for the erection of a shed and 250,000 frs. for electric lighting.

CANADA.—The Imperial Trade Correspondent at Toronto (Mr. F. W. Field) reports that a number of municipalities in the Province of Ontario have passed by-laws to enter into contracts for the supply to them of electrical power. Most of these municipalities will in consequence require various electrical plant for the purpose of distributing the power.

Several municipalities in Ontario have now ratified by-laws authorising the execution of electric power and lighting works, street railway extension, extension of water supply system, and building construction.

A company has been formed with a capital stock of 500,000 dols. to manufacture bare and insulated and underground, aerial and submarine cables.

It has been decided to expend 2,200,000 dollars on the extension of a hydro-electric system in Canada. The money will be expended from time to time on general electrical supplies, machinery and underground construction.

With regard to all the above mentioned works the addresses to which communications should be sent may be obtained by British manufacturers on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street London, E.C.

CHILE.—The "Diario" contains a decree granting to Don Felipe Gonzalez a concession for providing the town of Gorbea with electric light. Twelve months are allowed for the completion of the work. It also publishes a decree granting to Señores Paul Zañartu and Carlos Matte a concession for the installation of telegraph and telephone lines between Santiago and Valparaiso, with an intermediate station at Curacavi. Twelve months are allowed for carrying out the work.

Official announcement is also made of the grant to the "Compañia Electrica de los Andes" of a concession for the erection of electric generating stations for supplying electric light and power to the towns, villages and other country districts in the Departments of San Felipe and Los Andes, and also of the grant to Don Carlos de la Fuentes permission during 35 years to utilise 2,500 litres per second of the waters of the river Loa for the production of electric energy, and to Don Pedro Adams permission during 35 years to utilise 30 cubic metres of per second of water of the river Pilmaiquen for a similiar purpose.

MEXICO.—A contract has been made between the Mexican Government and Señor Domingo Barrios Gomez for the grant of a concession for a period of 10 years for the establishment in the Republic of a factory for the production of malt. Permission is granted for the importation free of duty of machinery, apparatus, and construction materials required for the factory, and of electric lighting and fire extinguishing appliances.

SPAIN.—The Ministry of Fomento has granted to the "Compañia Caminos de Hierro, Saltos y Minas" of Cataluña, a concession for the utilisation of 8,000 litres per second of the river Segre for the purpose of generating electric energy for industrial purposes. Six years are allowed for carrying out the work.

Electrical Company Notes.

METROPOLITAN DISTRICT RAILWAY.

The report for the half-year shows that in spite of a summer of a character inviting open air travel, the gross receipts increased by £14,800, or nearly 5%, the total being £315,600. The number of passengers carried rose from 36,552,300 to 39,051,500, a gain of nearly 7%, and though there was a decline in the average fare of 0·04d, passenger revenue increased under this head £13,400, or 4¾%. The number of ordinary travellers, it is indicated, grows five times as fast as the users of workmen's tickets and season ticket holders continue to increase, income from this source being £6,500 higher. The miscellaneous receipts are £1,600 better. Thought 2,499,200 more passengers were carried and train and car mileage increased respectively 5½ and 7¼%, working expenses show an increase of less than £300. Electric Traction absorbed only £800 more, and the superintendence of traffic required £1,100 additional, rates and taxes accounting for a further £4,500. Maintenance and works took £1,400 less and car repairs and general charges were also lower. The net revenue comes out at £164,800, as against £150,200. The balance brought in is £5,800 up and the proportion of earnings receivable from city lines and extensions and from the Whitechapel and Bow Railway is £3,300 up. The total at net revenue account is £228,100, or £23,900 more. Net revenue debits, including £10,000 set aside for renewals, are practically unchanged with the exception of general interest, which is £1,000 higher. The distributable surplus is £85,500, an increase of £22,500, and this provides the £7,500 needed to pay the 1% per annum extra on the First Preference stock and the £14,700 necessary for the 2% per annum on the Second Preference stock, without reducing the carry forward, which remains at £2,100. The capital expenditure during the half-year was £51,000, of which, £31,600 went for new rolling stock. The estimate for the current half-year is £50,000. There is a debit balance at capital account of £85,900, and to provide funds for new cars and for other purposes it is proposed to make an issue of Prior Lien Debenture stock.

TILLING-STEVENS OMNIBUSES.

As the result of the combination of Messrs. Thomas Tilling, Ltd., and Messrs. W. A. Stevens, Ltd., a new factory to be equipped with the most modern type of machine tools, electrically driven, for the rapid producton of the complete "Tilling-Stevens" Omnibus Chassis, is being built at Maidstone. The contracts for constructional steel work and the buildings have been secured by Messrs. Edward Wood & Sons, Ltd., of Manchester, and Messrs. R. Corben & Company, of Maidstone, respectively. Mr. Walter Wolsey, Junr., managing director of Thomas Tilling, Ltd., has joined the board of W. A. Stevens, Ltd., of which Mr. W. A. Stevens is chairman and managing director. The company has the advantage of the valuable experience of Mr. Percy H. Frost Smith, who, while retaining his position as chief engineer to Messrs. Thomas Tilling, Ltd., will have as works superintendent entire charge of the chassis construction. All chassis built at the new works will be identical with the 140 now on order for Messrs. Thomas Tilling, Ltd., and the Newcastle Corporation. The London offices of the company are at 26, Victoria-street, Westminster.

THE NATIONAL BOILER
and GENERAL INSURANCE CO., LD
Established 1864.
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London Office:—60, QUEEN VICTORIA STREET, E.C.

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EDWARD G. HILLER, B.Sc., M.Inst.C.E., M.I.Mech.E.,
Chief Engineer and General Manager.

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YOUR NEXT ENQUIRY WILL BE APPRECIATED.
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Chiswell Works, 122-124, GOLDEN LANE, E.C.

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PUBLICITY SECTION.

Notes on Novelties, Trade Specialities, New Catalogues and Lists, &c.

The Evolution of Light.

The latest powder and shot issued in the Osram Campaign takes the form of an artistic and attractive booklet entitled, "The Evolution of Light." Written in an interesting and instructive style, it deals with the various stages of light, from moonlight down to Osram light. Our illustration shows a selection of pages culled from the interior, together with the striking front cover design. The G.E.C. announce that they will be pleased to supply quantities of this booklet,

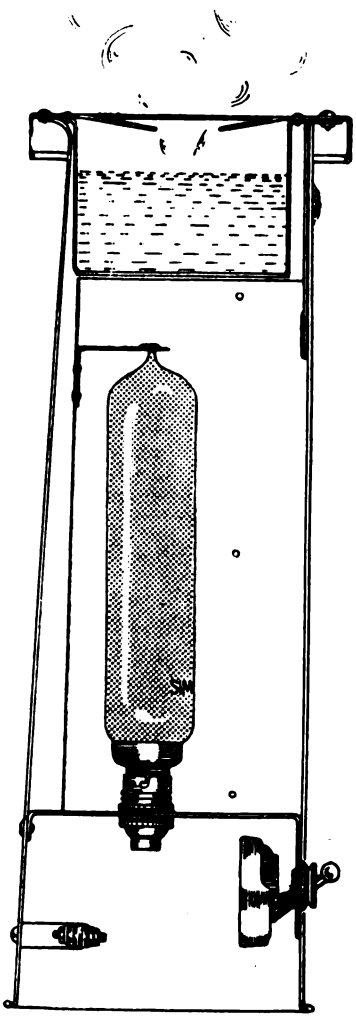
overprinted with contractors' names and addresses, free of all charge, upon application to their Publication Dept., 67, Queen Victoria-street, E.C. This booklet is so tastefully designed, brightly written, and well printed, that it cannot fail to interest the public and thus serve its desired purpose. We therefore strongly recommend all enterprising contractors to procure supplies and distribute them amongst lighting consumers in their own locality.

"Tantalum" Penny Stamps.

We illustrate here the latest type of advertising adhesive label which we understand Messrs. Siemens Bros. Dynamo Works, Limited, are prepared to supply in quantities to the trade for affixing to correspondence, invoices, etc., etc. In size it is slightly larger than a penny, and is printed in black on bronze paper, the head being a facsimile reproduction of the well-known "Satisfied Consumer" design, whilst the usual inscription GEORGIUS V. DEI GRA: BRITT: OMN: REX FID: DEF: IND: IMP. is replaced by the words "Tantalum" Lamps my Electric Light Bill Halved. The idea, which is novel and distinctive, should be appreciated by the enterprising tradesman, and a postcard enquiry addressed to the Lamps and Fittings Dept., Tyssen-street, Dalston, London, N.E., will ensure obtaining a supply free of charge.

Humidity with Electric Heaters.

It is generally recognised that electric heaters, either of the radiator or convector type, form the most healthful means of raising the air of a room to a comfortable temperature. Since no actual combustion takes place to produce the heat, the air is not impoverished by loss of oxygen, or made impure by the formation of gases injurious to the health. With all forms of artificial heating, however, it is necessary that the air of the room should be renewed at a constant rate and generally a means of communication with the outside atmosphere should be provided. This is also true with electric heating, not because the air is vitiated, but because any form of heat produces dryness and a loss of humidity. That the air we breathe should possess a certain degree of humidity is necessary to health as well as comfort. If a person remains in a dry atmosphere for any length of time an unpleasant feeling is caused in the mouth and there is produced a general sensation of depression. A coal fire is one of the most inefficient forms of heating, as by far the greater proportion of the heat units are lost up the chimney without having any effect upon the temperature of the room. Further, coal fire needs constant supply of oxygen for combustion, and consequently takes from the atmosphere the essentials for breathing, and renders it further impure by the gases resulting as the products of combustion. Obviously, therefore, a constant supply of air has to be arranged, and the air of a room changed at a



higher rate than with electric heating, and this causes draughts. With electric heating there is no impoverishment of the atmosphere by loss of oxygen, but since, when air is heated by whatever means, it gives up some of its moisture in proportional amount to the increase of temperature, any arrangement which while heating the air also supplies it with the necessary humidity, must be most suitable. Further, it is important to remember that with electric heating the air is not depleted of its oxygen, and the rate at which the air in a room is changed when using the types of heaters illustrated and described in this article need not be any higher than that for the ordinary ventilation required by human beings. Messrs. Simplex Conduits, Ltd., are introducing a new type of electric radiator which is especially designed to produce the necessary humidity of the atmosphere. The illustration shows a section of one of these heaters and indicates the arrangement of the water tanks. The heaters are made up in two and four lamp patterns.

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The Phœnix Dynamo Company, Ltd.

In view of the continuously increasing volume of their business, the Phœnix Dynamo and Manufacturing Company, Ltd., of Thornbury Works, Bradford, have increased their capital by the issue of £10,000 of six per cent. cumulative preference shares. The firm has in hand at the present time an exceptionally large number of important contracts, including the following: Wolverhampton Corporation: two 3,600-5,000 amp. motor-driven boosters; large Yorkshire flour mill: large alternator and motors; Farnham Urban District Council: two 150 kw. alternators, driven by Mirlees, Bickerton & Day Diesel engines; Bradford Technical College: turbine generator, three steam sets, and motor equipment for the new textile department; Birmingham Corporation: three booster sets each consisting of two 2,700 amp. dynamos driven by D.C. motors, two 350 kw. motors, three-phase, one 120 kw. motor; Northern Shipyard: one 3,700 amp. booster at 65 volts, one 3,000 amp. booster at 5 volts; Bury Corporation: one motor booster consisting of two 1,200 amp. dynamos driven by D.C. motor; large textile mill in Yorkshire: complete equipment comprising alternator driven by Belliss engine and 250 b.h.p. of motors; Irish linen mill: 170 kw. alternator and 200 b.h.p. of motors; Crown Agents for the Colonies: two 170 kw. alternators driven by Diesel engines; Watney Combe Reid, brewers, London: three 150 kw. D.C. generators and 300 b.h.p. of motors; Birmingham Metal Works: electrification of two works about 200 b.h.p. motors from corporation mains; oil mills in Hull: several large motors for oil mill combination. They have on the books at the moment electrification for no less than seven large textile factories and several screening equipments for English Colliery Companies, as well as two Colonial paper mill installations. Recent orders also include seven 200 b.h.p. 3,000 volt pump motors at about 1,400 r.p.m. and a large number of Phœnix patent explosion proof motors for fiery coal mines. Building extensions are in hand and will be ready for occupation before the end of March.

Venner Signs.

The great increase in the demand for Venner Signs has, we are informed, decided the patentee, Mr. R. F. Venner, to take over the entire manufacture himself, and while the Credenda Works at Birmingham will continue in full swing, new and separate works will be immediately equipped in London. In future, therefore, all communications should be addressed to Messrs. Venner & Company, 6, Old Queen-street, Westminster. These signs, it should be mentioned, are all made under "Venner" patents and are characterized by the advantage of being capable of being read at any angle and at ranges greater than obtained by any other methods, while by the combination of glass spheres of very varying diameters, any design, however complicated, can be faithfully copied and reproduced so as to get a brilliant outlined picture by night. A few of the new signs erected recently in London comprise such catholic taste in menus as supplied by the Eustace Miles Restaurant, Chandos-street; Quadrant Restaurant, Regent-street; Hotel Victoria, Northumberland Avenue, "Theatre Suppers"; "Clarnico Lily Caramels," The Borough; 50 Dewar's whisky signs, generally distributed, etc. It is worthy of note, also, that the well-known Coliseum sign has now been converted from incandescent to arc lamps, opening up the probability of a revolution in long range advertising.

Prometheus Electric Heating.

The British Prometheus Company, Ltd., of Salop-street Works, Highgate, Birmingham, and 9, Newman-street, Oxford-street, London, W., have just issued a new illustrated catalogue (No. 146) dealing with their latest type of electric heaters. Copies of this will be forwarded to inquirers on receipt of trade card. A noteworthy feature of these Prometheus specialities is that the heaters are now guaranteed for a period of five years. Prometheus apparatus, it may be mentioned, is now in use at Buckingham Palace and other royal households: the Royal Yacht, the "Medina," and ships of the following fleets: the Royal Navy, the French Navy, the German Navy, the U.S. Navy, the Italian Navy, the Japanese Navy; the Lyceum, the Comedy and other West End theatres; the London and North Western Railway, the Midland Railway, the Great Western and other railways; London and Provincial hotels and clubs; also on the undermentioned passenger steamships: "Lusitania," "Mauretania," "Rotterdam," "Olympic," "Titanic" (in hand), and other large ocean-going liners.

Synchronome Electric Clocks.

The Synchronome Company, of 32 and 34, Clerkenwell-road, E.C., inform us that among other important contracts for electric time services which they have in hand at the present time are the following:—The Sun Fire Insurance Offices, Hull; The Royal Insurance Company, Lombard-street, E.C.; The Law Union and Rock Insurance Company, Chancery-lane; London and North Western Railway, Broad-street Goods station, Broad-street Passenger station, and Birmingham; Caledonian Railway Company, Buchanan-street station, Glasgow; Midland Railway Company, Adelphi Hotel, Liverpool; London County Council Central School of Arts and Crafts; "Sheffield Telegraph" Offices, Sheffield; Royal Palace Hotel, Kensington; Cavendish Club, Piccadilly; John Bright & Bros, Rochdale; Sage's new factory, Peterboro'; Warehousemen and Clerks' Orphan Schools, Manchester; National Provincial Bank, Nottingham; Town Hall, Hackney; etc.

Ferranti Repairs.

The Westminster Engineering Company, Ltd., having purchased from Messrs. Ferranti, Ltd., all the necessary drawings, plant and tools, are prepared to carry out repairs or supply new spare parts to Ferranti alternators, rectifiers, etc. Messrs. Ferranti have advised their customers to this effect. The Westminster Engineering Company, Ltd., have for some years devoted a portion of their works to electrical repairs, and are in a position to give prompt delivery. They also bring machines of old design up to date, fitting interpoles where necessary, new commutators, new brush gear, etc.

POST OFFICE REGULATIONS AND STICKY BACKS.

Some weeks ago it was announced in the daily papers that the Post Office Authorities deprecated the use of adhesive stamps on envelopes which were of similar size to the ordinary postage stamp or which may tend to confusion in cancelling the postage stamps. It was stated that such letters may be held up in post, and thereby delay in delivery would be caused. The practice of using adhesive labels on correspondence has been encouraged by many firms, and has been adopted by several of the metal lamp concerns. Messrs. Siemens Bros. Dynamo Works, Ltd., Tyssen-street, Dalston, who were the first electric lamp firm to adopt this method of advertising, inform us that they have communicated with the G.P.O. authorities on this subject, submitting the various types of adhesive labels used by them with a view to ascertaining whether such labels would infringe the postal regulations in any way, and have received the following reply from the Secretary: "With reference to your communication of the 5th instant, I am directed by the Postmaster-General to inform you that the labels of which you enclosed copies are not of such a character as would render postal packets to which they were affixed liable to be stopped in the post." Hence all types of adhesive labels now issued to contractors by Siemens Lamp Department (including the new "Satisfied Consumer" penny stamps) may be used with safety by members of the trade on their outgoing mail, although care should be taken not to affix them in such a manner as to interfere with the addressing of the postal packets.

The A.E.G., the Elektrizitatslieferungsgesellschaft and the Lahmeyer Gesellschaft have put their heads together to found a new company with £300,000 capital. It is to be called the Thuringische Elektrizitatsgesellschaft, and as its name implies, is intended to sell electric power in Thuringia.

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CLASSIFIED DIRECTORY.

MANUFACTURERS AND MERCHANTS.

Accumulators.
Essex Accumulator Co., Leytonstone, London, N.E.
Hart Accumulator Co., Marshgate-lane, Stratford.
Johnson & Phillips, Old Charlton, Kent.

Accumulator Acid Manufacturers.
Spencer, Chapman & Messel, 36, Mark-lane, London, E.C.

Acid Proof Paints.
Griffiths Bros., Mack's-road, Bermondsey, S.E.

Ammeters and Voltmeters.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Arc Lamp Hoists.
London Electric Firm, George-st., Croydon.

Auto-Transformers.
British Westinghouse Electrical and Mfg. Co., Manchester.
Johnson & Phillips, Old Charlton, Kent.

Batteries (Primary) and Accessories.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Belting.
Willcox & Co., 36, Southwark street, S.E.

Boilermakers.
Babcock & Wilcox, 30, Farringdon-st., E.C.

Bolts, Nuts, Washers, Rivets & Screws.
Tetley Bros., Ltd., Floodgate Street, Birmingham.

Cable and Wire-Covering Machinery.
Johnson & Phillips, Old Charlton, Kent.
Feld Bros., 25, Rudge Row, Cannon Street.

Carbon Filament Lamps.
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.

Carbons (Arc Light).
General Electric Co., 71, Queen Victoria-street, E.C.
Johnson & Phillips, Old Charlton, Kent.
Mayer, H. G., & Co., 67, Aldersgate-street, London, E.C.
Sloan Electrical Co., Ltd., 15, Fore-street, London, E.C.

Cable and Wire Makers.
Callender's Cable and Construction Co., Hamilton House, Victoria-embank't, E.C.
Feld Bros., 25, Rudge Row, Cannon Street
General Electric Co., 71, Queen Victoria-st, E.C,
Hooper's Telegraph and Indiarubber Works. 31, Lombard-st., E.C., & Millwall Docks.
Johnson & Phillips, Old Charlton, Kent.
London Electric Wire Co., Playhouse-yd., E.C.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Casings and Cleats.
General Electric Co., 71, Queen Victoria-street, E.C.

Chemicals.
Spencer, Chapman & Messel, 36, Mark-lane, London, E.C.

Commutator Grinders.
Phillips Commutator Grinders Co., Ltd., 27, Walbrook, E.C.

Condensing Plant.
Allen, W. H., Son, & Co., Queen's Engineering Works, Bedford.
Belliss & Morcom, Ledsam-street Works, Birmingham.
British Westinghouse Electrical and Mfg. Co., Manchester.
Willans & Robinson, Victoria Works, Rugby.

Conduits.
Flexible Metallic Tubing Co., Ponders End, Middlesex, & 112, Queen Victoria-street.
General Electric Co., 71, Queen Victoria-st
Metallic Seamless Tube Co., Wiggin-street Birmingham.

Coppersmiths.
Andrews, R. W., & Co., 148-150, Pentonville-road, London, N.
Dore, J., & Co., High-st., Bromley-by-Bow.
Harvey, G. A. & Co., Lewisham, London, S.E.

Die-Finished Castings.
Aerators Limited, "Prana" Sparklet Works, Upper Edmonton, London, N.

Distributing Boxes & Wall Plugs.
Reyrolle, A. & Co., Ltd., Hebburn-on-Tyne

Dynamo Oil.
Willcox & Co., 36, Southwark-street, S.E.

Dynamos, Transformers, Motors, etc.
Allen, W. H., Son, & Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Morris-Hawkins, 30, St. Mary Axe, E.C.
Union Electric Co., Park-street, Southwark, London, S.E.

Ebonite and Vulcanite.
F. Carson & Evans, 3a, Fenchurch-buildings, London, E.C.
Mosses & Mitchell, 69, Chiswell-street, E.C.
North British Rubber Co., Ltd, Castle Mills, Edinburgh.
Traun, Dr. Heinr., & Son, 25, Goswell Road, London, E.C.

Electric Cooking Apparatus.
British Thomson-Houston Co., Rugby.
General Electric Co., 71, Queen Victoria-st.
British Prometheus Co., Ltd., Salop-street Works, Highgate, Birmingham.

Electrical Fittings and Appliances.
The Benjamin Electric, Ltd., 1a, Rosebery Avenue, London, E.C.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Dorman & Smith, Ordsal Station, Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Flexible Metallic Tubing Co., Ponders End, & 112, Queen Victoria-st., London, E.C.
General Electric Co., 71, Queen Victoria-st.
Lundberg, A. P., & Sons, Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Metallic Seamless Tube Co., Wiggin-street, Birmingham.

Electric Fans.
Edison & Swan United Electric Co., 36 & 37, Queen-street, Cheapside.
General Electric Co., 71, Queen Victoria street.
Gibbs, J. & Son, 72-76, Duke-street, Liverpool.

Electric Heaters.
British Prometheus Co., Ltd., Salop-street. Works, Highgate, Birmingham.
Bastian Electric Heating Syndicate, Ltd., 91-93, Palmerston House, E.C.

Electric Light Contractors.
British Thomson-Houston Co., Rugby.
Ferranti Limited, Hollinwood, Lancs
Hooper's Telegraph & Indiarubber Works, 31, Lombard-st., E.C., & Millwall Docks.
Johnson & Phillips, Old Charlton, Kent.

Electric Light Fittings.
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.

Electric Locomotives.
British Thomson-Houston Co., Rugby.

Electric Radiators.
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.
Dowsing, 105, Gt. Portland St., W.

Elevating, Conveying Plant, Cranes, etc.
General Electric Co., 71, Queen Victoria-st.
British Westinghouse Electrical and Mfg. Co., Manchester.
Ferranti Limited, Hollinwood, Lancs.

Electric Signs.
Caspar Signs Co., 33, Kings-road, St. Pancras.

Engines.
Allen, W. H., Son, & Co., Queen's Engineering Works, Bedford.
Belliss & Morcom, Ledsam-street Works, Birmingham.
Crossley Bros., Ltd., Openshaw.
Willans & Robinson, Rugby.

Engine Accessories, Tanks, etc.
Babcock & Wilcox, 30, Farringdon-st., E.C.
Dore, J., & Co., High-st., Bromley-by-Bow.
Harvey, G. A., & Co., Lewisham, London, S.E.
Willcox & Co., 36, Southwark-street, S.E.

Engineers' Stores.
Willcox & Co., 36, Southwark-street, S.E

Feed-Water Heaters.
Wilkinson, Geo., Beech Mount, Harrogate.

Fire Extinguishers.
Merryweather & Co., Greenwich, S.E.

Galvanisers.
Harvey, G.A., & Co., Lewisham, London, S.E.

Glassware. (Holophane, Etched, and Bead Shades).
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.

Indiarubber Goods.
Moseley, D., & Sons, Chapel Fields Works Ardwick, Manchester.
Willcox & Co., 36, Southwark-street, S.E.

Insulating Varnish.
Major & Co., Sculcoates, Hull.
Pinchin, Johnson & Co., Ltd., Bevis Marks. London E.C.

Insulators and Insulating Materials.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
General Electric Co., 71, Queen Victoria-st.
Griffiths Bros., Mack's-rd., Bermondsey, S.E.
Hooper's Telegraph & Indiarubber Works, 31, Lombard-street, E.C., & Millwall Docks.
Johnson & Phillips, Old Charlton, Kent.
Macintyre, J., & Co., Washington China Works, Burslem.
Mosses & Mitchell, 69, Chiswell-street, E.C.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.
Traun, Dr. Heinr., & Son, 8, Redcross-street, London, E.C.

Insurance Companies.
Phœnix Assurance Co., Ltd., 19 and 70, Lombard Street, London, E.C
The National Boiler Co., Ltd., Head Office, St. Mary's Parsonage, Manchester.

Jointing.
John Hudson & Co.'s Successors, 4, Victoria Warehouses, Mansell-street, E.

Ladders and Steps.
Heathman, J. H., & Co., Parson's Green, S.W.

Lamp Columns for Arc Lighting.
General Electric Co., 71, Queen Victoria-street, E.C.
Hardy & Padmore Ltd., Worcester.
Johnson & Phillips, Old Charlton, Kent.

Lamps: Arc & Metal Filaments.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Cryselco Ltd., Kempston Works, Bedford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Eichner & Co., 29, Priory Avenue, Hornsey, N.
Feld Bros., 25, Rudge Row, Cannon Street.
General Electric Co., 71, Queen Victoria-st.
Imperial Lamp Works (Brimsdown), Ltd., Kingsway House, Kingsway, W.C., Works, Brimsdown, Middlesex.
Johnson & Phillips, Old Charlton, Kent.
Stearn Electric Lamp Co., 47, Victoria-st., S.W.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.
Union Electric Co., Park street, Southwark, London, S.E.

Lampholder Makers.
Dorman & Smith, Ordsal Station Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
General Electric Co., 71, Queen Victoria-st.

Lead-Covered Cables
Callender's Cable & Construction Co., Hamilton House, Victoria Embank't, E.C.
Johnson & Phillips, Old Charlton, Kent.
London Electric Wire Co., Anchor Works, Playhouse-yard, E.C.

Manganesite.
John Hudson & Co.'s Successors, 4, Victoria Warehouses, Mansell-street, E.

Measuring Instruments—Electrical.
British Thomson-Houston Co., Rugby.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Ferranti Limited, Hollinwood, Lancs., E.C.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.

Metal Filament Lamps. ("Tantalum" and "Osmiwatt").
Siemens Bros. Dynamo Works, Ltd., Tyssen-st., Dalston, N.E.

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Classified Directory—Manufacturers and Merchants *(continued)*:

Mechanical Stokers and Conveyors.
Babcock & Wilcox, 30, Farringdon-st., E.C.

Metal Perforators—Speciality, Lead.
Harvey, G. A., & Co., Lewisham, London, S.E.

Meters.
Bastian Meter Co., Bartholomew Works, Kentish Town, N.W.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.

Motors—Electric.
Allen, W. H., Son & Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Churton, T. H., & Co., Atlas Works, Leeds.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Electromotorenwerke, Heidenau, 15, Bez, Dresden.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Morris-Hawkins, 9½, Union-court, Old Broad-street, London, E.C.
Union Electric Co., Park-street, Southwark, London, S.E.

Motor Starters & Controllers.
Reyrolle, A. & Co., Ltd., Hebburn-on-Tyne

Mica.
British Mica Co., Lebanon-road Works, Wandsworth, S.W.
Taylor & Co., 40, Hatton-garden, E.C.
F. Wiggins & Sons, 102, 103 and 104, Minories. London.

Oilcans and Economisers.
Kaye, J., & Sons, Leeds.

Oils, Paint, &c.
Callender's Cable & Construction Co., Hamilton House, Victoria Embankment, E.C. "Kalbitum."

Oil Separators.
The Baker Oil Separator Co., Ltd., Hunslet, Leeds.

Packings—Asbestos and Metallic.
Hooper's Telegraph & Indiarubber Works, 31, Lombard-street, E.C., & Millwall Docks.
Klinger, R. & Co., 66, Fenchurch Street, London, E.C.
United States Metallic Packing Co., Soho Works, Bradford.
Willcox & Co., 36, Southwark-street, S.E.

Petrol Air Gas Plants.
Safety Light Ltd., 117, Middlesex Street, London, E.

Platinum Utensils.
Derby & Co., 44, Clerkenwell-road, E.C.

Projectors.
Johnson & Phillips, Old Charlton, Kent.

Pumps.
Merryweather & Sons, Fire Engine Works, Greenwich, S.E.

Rheostats.
Adams' Mfg. Co., Ltd., 106, New Bond-st., London, and Bedford.
British Thomson-Houston Co., Rugby.
Ferranti Limited, Hollinwood, Lancs.

Silk and Lace Shades.
Taylor & Co., 40, Hatton-garden, E.C.

Ships' Electric Fittings.
Dorman & Smith, Ordsal Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.

Soldering Fluxes.
Auto Controller & Switch Co. (Fluxite), 70, Vienna road, Bermondsey, London.

Stampings and Metal Perforators.
Harvey, G. A., & Co., Lewisham, London, S.E.

Switchboards, Switches, Cut-Outs, etc.
Adams' Mfg. Co., Ltd., 106, New Bond-st., London, and Bedford.
British Thomson-Houston Co., Rugby.
British Westinghouse Electrical and Mfg. Co., Manchester.
Dorman & Smith, Ordsal Station Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Lundberg, A. P., & Sons, Pioneer Electrical Works, 477 to 487, Liverpool-road, N.

Tachometers.
Lunken Valve Co., 35, Great Dover-st., E.C.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Telephones.
General Electric Co., 71, Queen Victoria-st.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Testing.
Faraday House, 62-70, Southampton-road, London, W.C.

Tools.
Youngs, Ryland-street Works, Birmingham.

Tramway Equipments.
British Thomson-Houston Co., Rugby.
Ferranti Limited, Hollinwood, Lancs.

Turbines.
British Thomson-Houston Co., Rugby.
Willans & Robinson, Victoria Works, Rugby.

Ventilating Fans.
British Thomson-Houston Co., Rugby.
Capell Fan Co., 13, Mosley-st., Newcastle-on-Tyne.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Gibbs, J., & Son, 72, Duke-street, Liverpool.
Harvey, G. A., & Co., Lewisham, London, S.E.
Matthews & Yates, Cyclone Works, Swinton Manchester.

Vulcanite and Vulcanised Fibre.
Crumpsall, Fibre Rolling Mills, Crumpsall.

Zinc and Wire Workers.
Harvey, G. A., & Co., Lewisham, London S. E.

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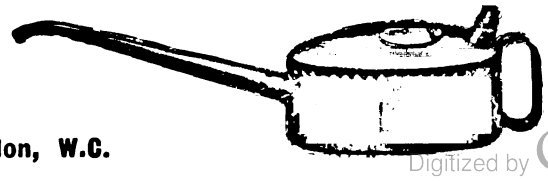

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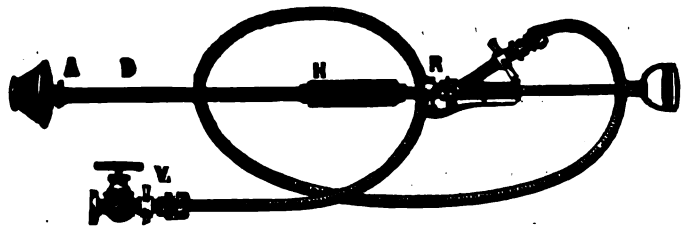

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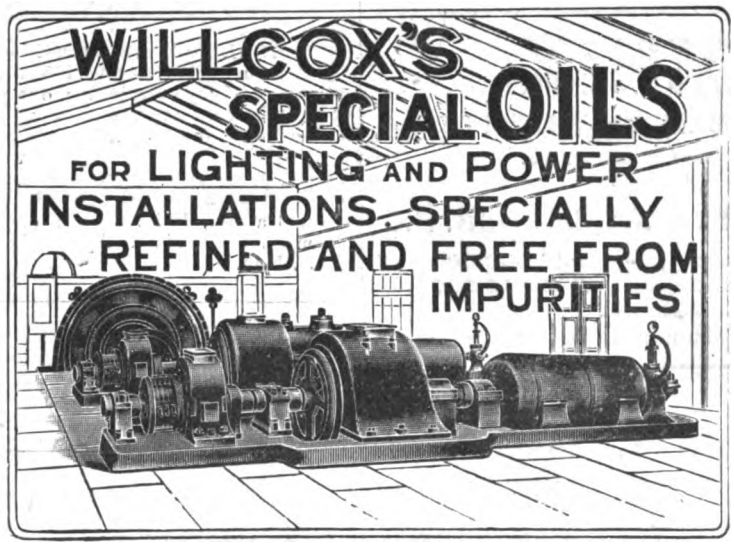

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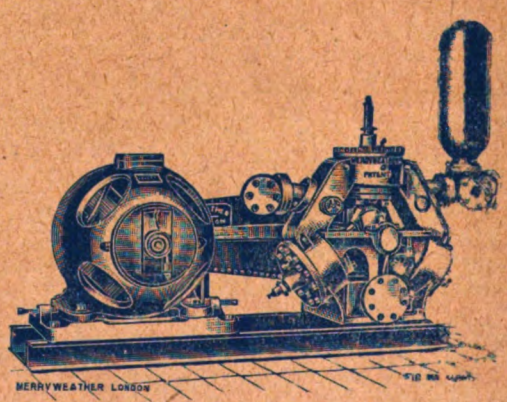

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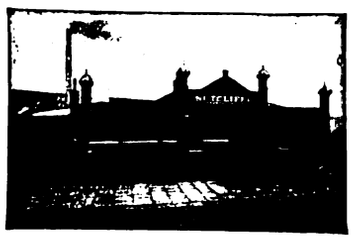

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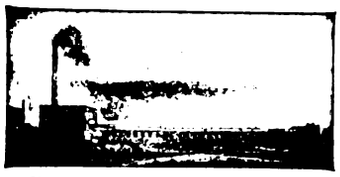

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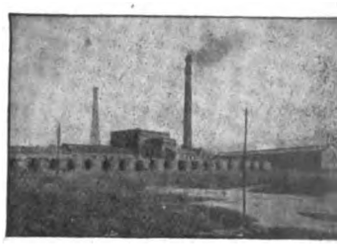

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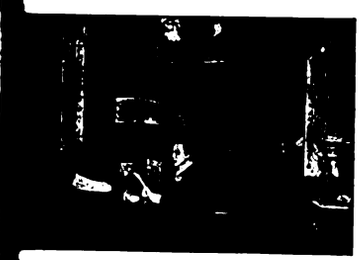

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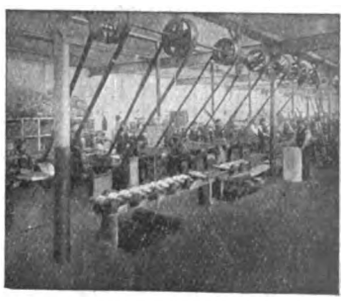

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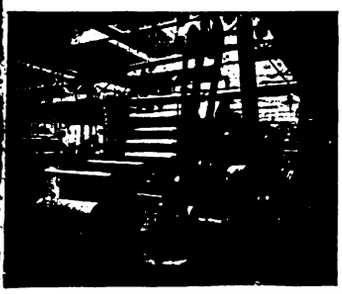

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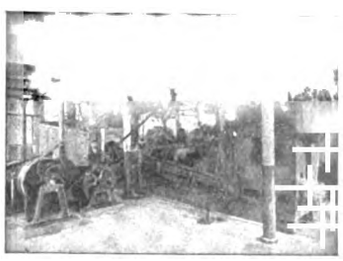

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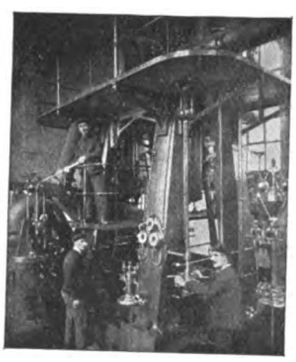

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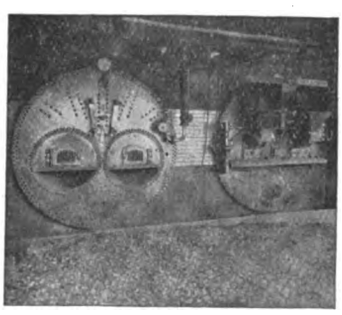

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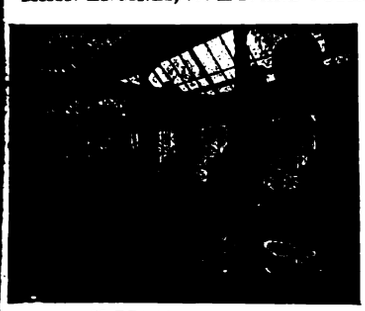

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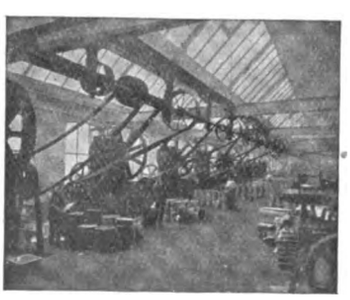

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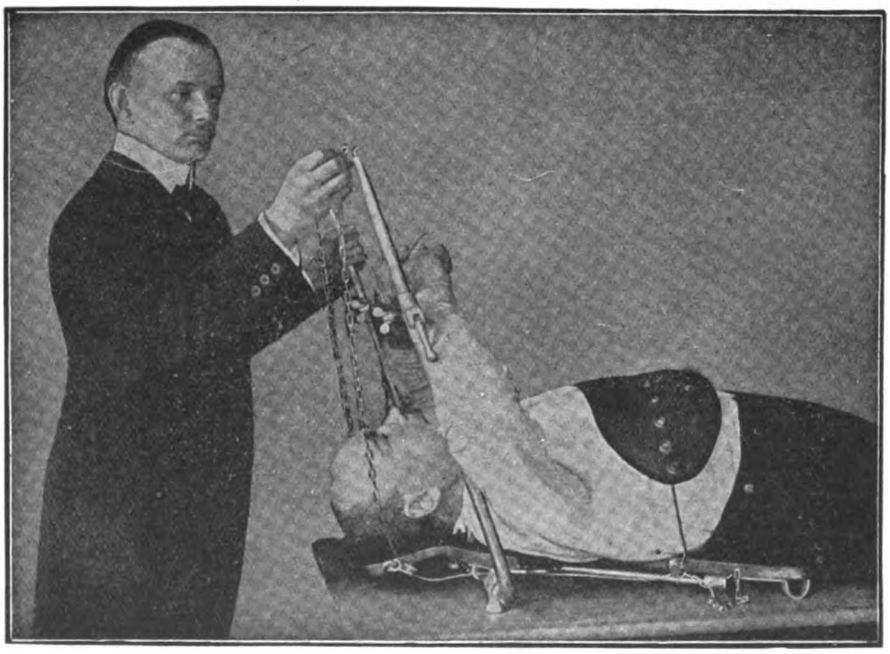

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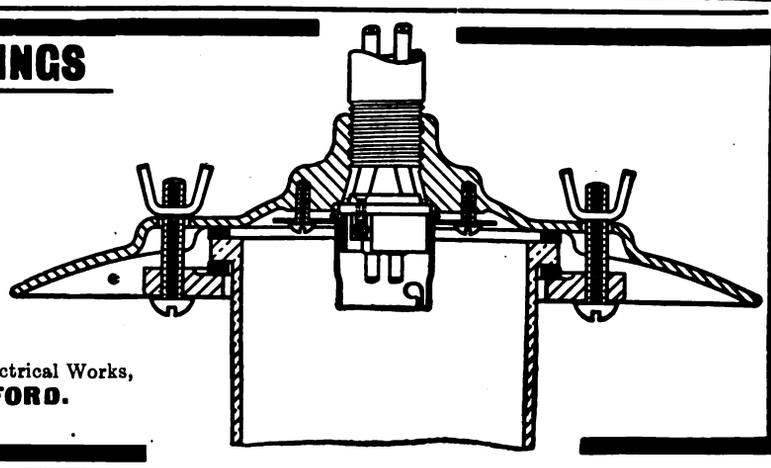

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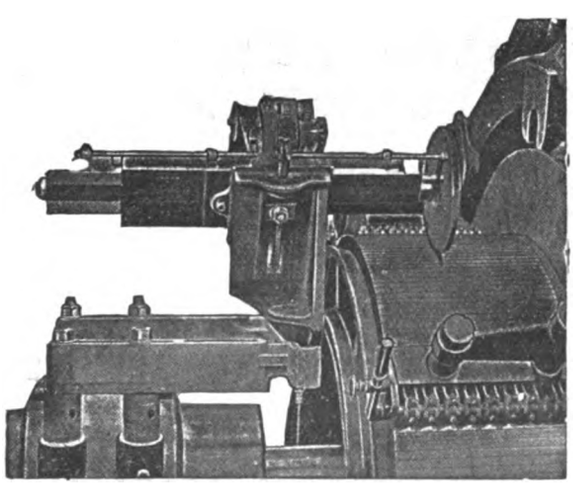

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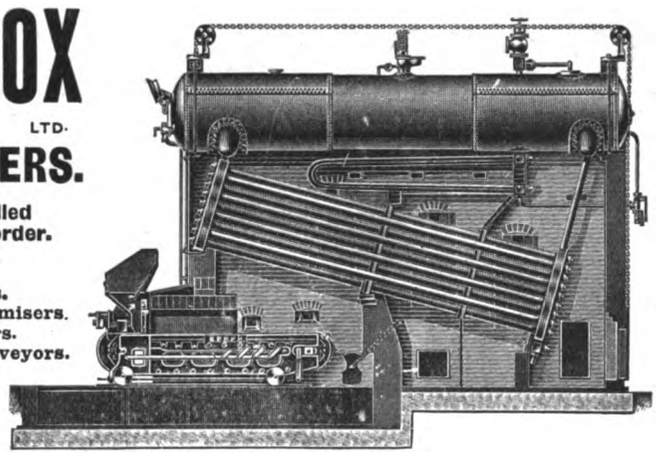

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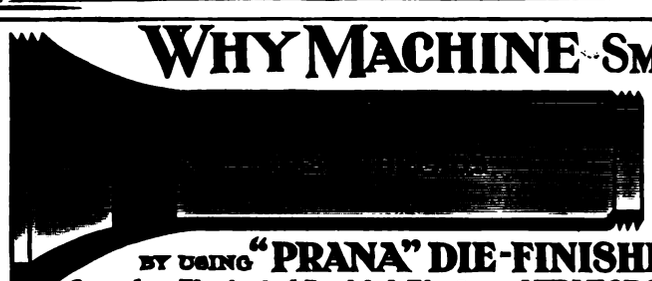

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LONDON, FEBRUARY 9, 1912.

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Important Announcement.

A STRONG COMBINATION.

We have an announcement to make which will be of considerable interest to all our readers. At the beginning of the year we were able to make public the information that the reduction in the price of **THE ELECTRICAL ENGINEER** from 3d. to 2d. had been so acceptable in electrical engineering circles that the circulation of our paper showed a very great and striking increase. It was, perhaps, a radical policy to adopt in the case of a technical journal of nearly thirty years' standing, but events have shown it to have been fully justified. It has had another, and to some extent an unexpected effect. The reduction in price and the widening of our circle of readers has brought us into serious competition with another journal, **"ELECTRICAL ENGINEERING,"** which had adopted a similar forward policy a few years ago with success even greater than our own. Those of our readers who are engaged in the manufacturing branch of the industry are aware of the serious effects which have been brought about in this country by over-competition, and, although the time has been too short for our contemporary to have been effected in the slightest degree in this direction, they have doubtless been influenced by the excellent maxim that "Prevention is better than Cure." The result of negotiations between the Proprietors has been that from next week onwards the two journals will be incorporated under the title **"ELECTRICAL ENGINEERING,"** with which is incorporated **"The Electrical Engineer,"** and the price of the combined paper will be 1d. weekly (1½d. post free).

As hitherto, the journal will be first and foremost a newspaper—interesting and up-to-date, and, in fact, indispensable to electrical engineers and others in the electrical industry. Among the new features to our readers will be a "Summary" of news at the commencement of the Paper each week, a fortnightly cartoon forming a pictorial comment on the events of the day or giving expression to a humorous thought of the moment, a more comprehensive record of new electrical patents, notes with regard to Prospective Business for the benefit of manufacturers and suppliers of electrical goods, a monthly Supplement on "Electrical Engineering in Mines" (published on the first Thursday of every month without extra charge), and the periodical inclusion of a free Literary Supplement containing reviews of the latest books on electrical engineering subjects. The Editorial Staff is composed almost entirely of experienced electrical engineers, and the contributors to the Paper include men of the highest standing in the profession.

The Paper will in future be published by the KILOWATT PUBLISHING CO., LTD., 203-206, Temple Chambers, London, E.C., to whom all communications should be addressed, and will appear on Thursdays. It will be on sale at Messrs. W. H. Smith & Sons and Messrs. Wyman's Bookstalls and by the leading newsagents throughout the country. Subscribers will receive their copies as hitherto, and advertisers will have the benefit of the combined circulation of the two Papers.

Instruct your newsagent to supply "ELECTRICAL ENGINEERING" (with which is incorporated "The Electrical Engineer"), price 1d. from next Thursday onwards.

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NOTES.

ALWAYS one of the great Science festivals of the year, the annual dinner of the Institution of Electrical Engineers brought a gathering of something like five hundred men of light and leading to the Hotel Cecil last week under the genial chairmanship of Mr. Ferranti. Among the non-electrical, though nevertheless very welcome and distinguished guests, were the Lord Chief Justice, Lord Justice Buckley, Lord Justice Fletcher Moulton, Mr. Justice Parker, Sir George Reid, the versatile High Commissioner for the Australian Commonwealth, without whose smiling presence no modern banquet seems complete; Sir J. W. Taverner, the Agent-General for Victoria; Sir Newton Moore, the Agent-General for Western Australia; Sir Horace Monro, of the Local Government Board; Sir Lawrence Gomme, of the London County Council; Sir A. Whitelegge, the Chief Inspector of Factories; Sir T. Barlow, and a host of other well-known public men. As representing Science there were Sir J. Larmor, President of the Royal Society; Sir Charles Parsons, Professor Silvanus Thompson, Mr. Alexander Siemens, Professor Perry, Professor Unwin, Mr. W. Duddell, Sir W. Ramsay, Sir Norman Lockyer, Sir A. B. Kempe, Dr. W. N. Shaw, Professor Mather, and many more. The toast of the evening was proposed in happy terms by Lord Alverstone; and Mr. Ferranti, in the course of his reply, took advantage of the opportunity of mentioning the hope of himself and the Council that by means of the much-discussed proposals they have in hand, they would be able so to broaden the basis of the Institution as to embrace within it all those who were associated with the progress and development of electrical enterprise.

WE learn from Boston that the prospects of the great electrical exhibition to be held there from September 28 to October 26 are very rosy. Already over sixty per cent. of the available space—105,000 square feet—has been taken, and the manager assures us, in a letter to hand by this week's mail, that if they "should not sell another foot of space the success of the show as the biggest exhibition of the kind ever given would be assured, but every mail is bringing in inquiries and we have no doubt there will be an over subscription for space and that some of the late comers will have to arrange for co-operative exhibits with those who have no allied lines in the electrical field." The interest evinced in the 1912 Boston Electric Show on this side of the Atlantic is already very marked, but we would once more urge upon our leading manufacturers that there is here an opportunity of showing what Great Britain can do, which should by no means be missed. The building in which it is to be held—the great Mechanics Building—gives accommodation for upwards of one hundred thousand visitors, even after all the space allotted for exhibits has been filled. The organisation of the Show, the financial responsibility of its management, and the whole scope and policy of the undertaking are under the auspices and supervision of the Edison Electric Illuminating Company, of Boston, which supplies not only Boston itself, but thirty-seven other cities, covering an area of five hundred and fifty square miles; and the Company has no intention of making a profit on the show either for itself or for any individual or group of individuals, but is undertaking this great work to promote the electrical industry and to familiarise the public with the possibilities and economy of electric service. Direct current 110 and 220 volts and alternating current 110 and 220 volts single-phase and 220 volts three-phase (60 cycles) will be supplied, and the management will supply current for light and power at the rate of three halfpence per kilowatt hour.

GERMANY is again ahead of us in a simple but important system, the adoption of which has long been advocated in this country and especially in London, namely, the electrical synchronization of public clocks. According to "The Times," the whole of the public clocks, not merely in Berlin, but throughout the whole German Empire, are to be synchronized by means of wireless telegraphic signals, which will be sent out by the German Imperial Post Office from the new station under construction at the town of Fulda. The master clock at Fulda will actuate the radio-transmitter once each minute, and the signals will be radiated from the new tower, which will be over 300 ft. high. If no interference is caused from ordinary wireless signals, the system will enable all public clocks in any country to be kept in absolute synchronism without supervision. One of the daily newspapers took a census recently of a comparatively small proportion of the public clocks of London and it was found that from slow to fast, the total variation was about twenty-one minutes, the clocks which gave true Greenwich time being something like three-and-a-half per cent!

CONTINUING our benevolent work on behalf of the Commercial Gas Association, we condense two paragraphs which appeared in last Saturday's papers. One relates how the Flying Horse Hotel at Kegworth, in Leicestershire, was wrecked by a gas explosion. A smell of gas was detected in the dining room and after the door had been left open for a quarter of an hour to let the deadly fumes escape, an attempt was made by two women to investigate the source of the trouble. The usual terrific explosion followed. "The front of the hotel overlooking the High-street was blown out, and the roof shattered. The two women had a terrible experience. Both were dashed to the floor and cut. The door was closed fast by the explosion, and for some time they were imprisoned in the room, which had taken fire. Ultimately the women forced open the door, fetched a patent fire extinguisher, and pluckily put out the flames." The other case was nearer home—in Islington, in fact. In this case the top of a gasmeter in the basement of a shop in Essex-road blew off. "Two vans happened to be passing at the moment, the drivers of which were blown from their seats into the roadway, while the two vehicles were thrown towards the other side of the street, and the horses were singed. The windows of the shops and houses in the immediate neighbourhood were smashed, and at a drapery establishment the windows of the workroom on the second floor were demolished, as well as the four plate glass windows on the street level. Other shop windows were broken, as well as those in a number of private houses. A large quantity of glass was left in heaps in the road, while other glass which had been blown to powder settled on the streets like rain. The driver of the van was severely burned and was also cut by the falling glass. A boy was blown off the rear of the van and severely cut about the face." On the following day another terrifying incident occurred. This time the scene was Darwen, at the house of Mrs. Reeling, widow of the famous breeder of collies. In this case a gas pipe broke under the floor, and though doors and windows were thrown open, the escaping gas reached the grate of the sitting room where a fire was burning. "The house was completely wrecked and great damage was done to adjoining property. An inner wall was blown down, the flooring torn up and the walls shattered. Every window in the house was blown out and the furniture reduced to matchwood. Four persons were shockingly injured, two sustaining broken legs and a third serious injuries to the spine." Such a nice, safe thing, Gas!

THE opponents of the tube and omnibus amalgamation scheme have so far got their way that it has been agreed that no further steps shall be taken by the London General until a meeting of the Preference shareholders shall have taken the whole question into consideration and until the Ordinary shareholders shall have had more time in which to make up their minds. When the motion on behalf of Mr. Howard Moore and Mr. Lea Smith came up before Mr. Justice Neville in the Chancery Division, these facts were only stated, and Mr. Astlay, for the plaintiffs mentioned that his clients had asked for a declaration

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that certain annuities and benefits to be taken by the omnibus company's directors were fraudulent and not binding on the company. That was only intended, he explained, in the legal sense of being *ultra vires* and a breach of duty as directors, and he said he desired to state without any reservation that the plaintiffs had not intended to make, and did not make, any charge of personal bad faith of any sort or kind against any of the defendant directors. On this Mr. Buckmaster, for all the defendant directors except one, desired to state that there had never been any arrangement suggested or made for giving them benefits, except in consideration of a condition of affairs which might or might not arise, namely, their relinquishing their positions on the board and never entering into similar undertakings. It was not fair to suggest that there were any unconditional benefits. So there the matter stands for the moment, the only other development being the support given to the amalgamation proposal by Mr. C. B. Stuart Wortley, the chairman of the City and South London, who at the half-yearly meeting of that Company, expressed the view that if the arrangement went through, it might be expected to result in a more systematized method of working so as to afford the greatest possible facilities to the public without resorting to any increase in fares.

IT is not a little curious that while Birmingham, notwithstanding its close association with a certain famous propaganda, should favour foreign tramway rails, London, with no such associations, should favour the British product to the exclusion of the German article. When Birmingham advertised a few weeks ago for tenders for a supply of steel tramway rails and fishplates, Messrs. Bolling & Lowe, of London (representing the Phœnix Steel Works, Ruhrort, Germany), asked £11,460 11s., the Lorain Steel Company, of London (whose rails are manufactured in America) asked £12,493 18s. 6d., and Messrs. Walter Scott, Ltd., of Leeds, asked £13,155. The Tramway Committee, in presenting these figures, said "it will be observed that the German tender is £1,694 9s. lower than the English tender, and that the American tender is lower by £661 1s. 6d. Your Committee, after giving the matter most careful consideration, particularly with regard to the actual experience in Birmingham of the wear of both German and English rails, feel bound to recommend the Council to authorise the acceptance of the tender of Messrs. Bolling & Lowe (as representing the German firm above named) at the sum of £11,460 11s." When the London County Council sought tenders for similar rails, they were asked £22,563 15s. for German rails of Sandberg high silicon steel, and £26,592 10s., plus £863, for royalty and supervision charges, £27,355 10s. in all, for English rails of comparable quality, or £4,792 more than the price of the German rails. Nevertheless the Highways Committee recommends the acceptance of the British tender, one of their reasons being that the difficulties of inspection during manufacture are greatly increased when the rails are made abroad, and the same control cannot be exercised over the work. But in the sequel the recommendation of the Birmingham Highways Committee was rejected. Mr. Walthall moved as an amendment that Messrs. Walter Scott's tender be accepted, and this was carried by forty-three votes to twenty-nine.

"Seagumite."

Since the article which appeared in our last week's issue describing the manifold uses of the remarkable new product called "Seagumite" was put in type, the Rt. Hon. Lord Norton has joined the Board, the Directors now being Lord Tenterden (chairman), Lord Norton, and Mr. W. J. Potter. We understand that the capital of the Company is being privately subscribed, and that investors are keen on securing shares, as the profit on the material promises to be very large. The registered offices of the British Seagumite Company, Ltd., are at 26, Shaftesbury-avenue, W., where prospectuses can be obtained.

PANAMA EQUIPMENT.

It is announced that the award of the contract for the hydro-electric power plant at Gatun, Canal Zone, has been authorized to the Pelton Water Wheel Company for the water turbines at $85,200; the General Electric Company for the generators at $54,534, and the Niles-Bement-Pond Company for cranes at a price to be determined later. This equipment is for the generating station that will furnish power to operate the gates, valves and other machinery of the locks, the regulating works of the spillways of Gatun and Miraflores dams, and will furnish the light for the same, as well as light and power all along the canal. The site for the power station is near the head of the spillway and the tailrace arches already built in the spillway wall can be utilized. The General Electric Company undertakes to furnish three generators, 250 revolutions per minute, weight 116-200 lbs. Delivery under the contract will begin in 140 days and be finished in 200 days.

The "Synchron" Apparatus.

The "Synchron" Life-Saving Apparatus for the Promotion of Artificial Respiration in cases of Electric Shock, Drowning, Mine Gas Poisoning, etc., is now being manufactured for us in London and Birmingham under expert personal supervision, and all orders are being filled in rotation as speedily as we can obtain supplies of castings.

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The Charing Cross, West End and City Electricity Company, Ltd.
The Metropolitan Electric Supply Company, Ltd.
London Electric Supply Corporation, Ltd.
Stepney Borough Council Electricity Dept.
Islington Borough Council Electricity Dept.
South Metropolitan Electric Tramway and Lighting Company, Ltd.
Croydon County Borough Electricity Works.

COUNTRY.

Glasgow Corporation Electricity Dept.
Clyde Valley Electric Power Company, Ltd.
Manchester Corporation Electricity Dept.
Lancashire Dynamo and Motor Company, Ltd.
The British Thomson-Houston Company, Ltd.
Ayr Corporation Electricity Works.
Messrs. Harland & Wolff, Ltd., Belfast.

ABROAD.

Messrs. Andrew Moir & Company (for South Africa).
Messrs. Strachan Oswell & Company (for South Africa).
The Bakhtiari Oil Company, Ltd.
The Anglo-Persian Oil Company, Ltd.

OTHER ORDERS.

Victoria Falls and Transvaal Power Company, Ltd. (12 machines).
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The Mersey Docks and Harbour Board.
The Manchester Ship Canal.
Messrs. H. Simonis & Company, Fire Engineers.
Messrs. Henry Morgan & Company.

Many of the orders referred to are for 6 and 12 machines and upwards.

Inquiries should be addressed to the Manager, The Electrical Engineer, Ltd., 149, Fleet Street, E.C., by whom illustrated descriptive pamphlets will be sent post free on application.

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The Father of Electrical Science.

William Gilbert, of Colchester.

Notes, biographical and otherwise, of the early philosophers, writers, and navigators mentioned by him in "De Magnete." Some curious observations and opinions especially concerning the loadstone and several objects magnetical.

(*Continued from page* 114).

PTOLEMÆUS, CLAUDIUS, the great Egyptian mathematician, geographer and astronomer, who flourished in the middle of the second century after Christ, is frequently alluded to throughout four of the books of *De Magnete* and Gilbert makes direct reference to the *Opus Quadripartitum*, the *Cosmographia* and the *Geographia*. The last named, of which the earliest edition appeared in 1478, is however the work with which Ptolemy's name is most prominently connected. It was the standard up to the time of the marine discoveries of the fifteenth century and has been translated and published into editions too numerous to mention here. Gilbert's references embrace Ptolemy's *Opus Quadripartitum* wherein it is stated, as it was held by Plutarch, that the loadstone does not attract iron either when it is rubbed with garlic or when it is in presence of a diamond. And, in the same book, Ptolemy likewise makes error when laying out eastern and western divisions to which he improperly annexes the planets. When speaking of the *Cosmographia*, mention is made of the fact that very few places were observed in elevations of the pole before Ptolemy's time and of what Hipparchus wrote concerning the latitudes of places and distances, some of which are cited by Stadius and confirmed by Vitruvius, as taken from the *Geographia*. It is in Liber VII of the last named work that Ptolemy gives an extraordinary account of magnetic rocks and mountains, to which allusion has been made in the writings of Fracasterio, Olaus Magnus, Nicander and others.

PYTHAGORAS. Celebrated Greek philosopher (569–470 B.C.) who, as Heyel says, "first make thought and not sense the criterion of the essence of things," was a native of Sames, who, after travelling extensively, settled finally at Crotona in Lower Italy during the year 529 B.C. and there established the school that has made him famous. Besides the reference in the Parmenides entry, allusion is made by Gilbert to Pythagoras in his second book treating of magnetic movements. Attraction—the unity of bodies—is, according to Pythagoras the principle, through participation, in which a thing is said to be one. For says he, "as no action can be performed by matter save by contact of necessity, something is given out from the one to the other to come in close relation therewith, and be a cause of incitation to it."

RHAZĒS—RASIS—ABU BEKR AL RAZI—born at Rai, is said to have died about A.D. 923. He was one of the most famous of the ancient Arabian physicians and is the author of several important works, notably *De Simplicibus ad Almansorum*, the ten books of which contain a complete system of medicine. Gilbert notes Rhazēss' prescription of an electuary of iron slag, or of prepared steel filings, as a highly commended and celebrated remedy for dried-up liver, the Arabians believing that iron opens both the spleen and the liver.

RUELLIUS, JOANNES (1479–1537) was a French physician attached to the court of Francis the First who wrote a Commentary on Dioscorides as well as several medical treatises. The treatise by which he is best known is *De Natura Stirpium*, Paris 1536, reprinted four times at Basle and at Venice, which contains much about amber, the magnet and other stones and from which Gilbert extracts the mention made by Ruellius that the loadstone's force, when failing or dulled is restored by the blood of a buck.

RUEUS, FRANCISEUS—FRANCOIS DE LA RÜE—(1520–1585) Flemish naturalist who long practised in his native country and author of *De Gemmis . . .*, which was later printed with the book on philosophy of Vallesius and also with the *Similitudines* of Levinus Lemnius. Gilbert, when speaking of the many fables and fairy tales current about the loadstone, tells us in his opening chapter that amongst some of the many questions raised by Rueus was whether it is an imposture of cacodæmons that the loadstone withdraws bolts or opens locks as Serapio imagines, or that iron held by a loadstone's attraction, being placed in a balance adds naught to the weight of the loadstone as though the weight were absorbed by the virtue of the loadstone.

SANUTO, LIVIO, Italian geographer of the sixteenth century, died about 1587. We are told by Gilbert that in his *Geografia* Sanuto discourses at length of the prime magnetic meridian, of the magnetic poles, whether they are terrestrail or celestial, and treats also of an instrument for finding the longitude, besides giving an account of Sebastian Cabot's magnetical observations.

SCALIGER, JULIUS CAESAR (1484–1558) was a famous Italian scholar who practieed medicine at Verona until 1525 and afterwards devoted his time to writing on various subjects. His best known books are *In Aristotelis de plantis*, *In Theophrasti, de causis plantarum* and *De Subtilitate ad Cardanum* of which appeared numerous editions. It is to the last named work that Gilbert mainly alludes. He remarks, more particularly, that "Scaliger strays from the truth when, in treating of magnetic bodies, he speaks of diamond attracting iron, also of keeping the loadstone and iron in bran to protect them from the injurious action of the atmosphere; and that, in order to explain the difference of variation for change of locality, he brings in a celestial cause, to himself unknown, and terrestrial loadstones that have nowhere been discovered: seeking the cause not in the 'siderite mountains' but in that force which formed them, to wit, in the part of the heavens which overhangs the northern point."

SÉRAPIO MAURITANUS—YUHANNA IBN SÁRAPION—Arabian physician living in the ninth century. He is the author of *De Simplicibus Medicinis* wherein it is said that Sérapio and the Moors report there are in Indian seas certain sharp-pointed rocks abounding in loadstone, the which draw every nail out of the ships that land alongside them and hold them fast. He indulges in other fables, as stated in the Rueus entry, and makes much of Calen's prescription of iron scoriæ alluded to by Gilbert in his Bk. I, Ch, 14.

SEVERTIUS, JACOBUS—JACQUES SEVERT—a native of Paris, is the author of *De Orbis Catoptrici*, 1598. Gilbert merely says that after quoting in this work a few observations of others, Severtius fashions new errors as to loadstones of various regions being different in direction, as also about the eastern and western parts of the loadstone.

SILVATICUS—SYLVATICUS—MATTHÆUS MORETUS, well-known Italian savant, living in 1344, was physician to the King of Naples and one of the professors at Salerno. He is mentioned by Gilbert in his first chapter, as stated in the Agrippa entry, and is the author of *Liber Cibalis et medicinalis Pandectarum*. This was originally published at Naples in 1474 in the form of an encyclopædic dictionary and is one of the most important books we have of the history of medicine both in the middle ages and at beginning of the Italian Renaissance.

SELINUS, CAIUS JULIUS—GRAMMATICUS—a Roman writer who lived in latter part of the second century and author of a compilation in fifty-seven chapters containing a sketch of the world as it was known at the time but which is supposed to have been taken entirely from

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Pliny's Natural History. This, one of the earliest known printed books was originally published in 1473 under the title *Collectanea rerum mirabilium* and it has since been translated into many foreign languages. The most important of the many references made by Gilbert is found in his Bk. II, Ch. 38, already mentioned in the Pliny entry.

STEVINUS, SIMON, great Flemish mathematician, who was born at Bruges 1548 and died at the Hague in 1620, is the author of many works, one of the most important of which being "The Haven-finding Art" 1599, wherein he describes the sea directerie and nautical box or sea compasse. Gilbert remarks that the grounds of variation in the southern regions of the earth which Stevinus searches into are utterly vain and absurd but the method of finding port on long voyages to distant parts by means of accurate knowledge of the variation (a method invented by Stevinus and recorded by Gratius) is of great importance, if only fit instruments be at hand wherewith the deviation may possibly be ascertained at sea.

TAISNER—TAISNIER—JOHANNES, was born in 1509 at Ath in Hainault (hence Hannenius). His name appears as author of *De Natura Magnetis*, 1562, the whole of which was taken bodily from the work of Peter Peregrinus as well as from other works pilfered from Joannes B. Benedictus. Gilbert says of him that it was "from the book of Petrus Peregrinus Taisner extracted the matter of a little volume which he published for new." Speaking of the perpetual motion engine delineated by Peregrinus he adds that "Taisner published this, illustrating it with wretched figures, and copying word for word the theory of it. May the Gods damn all such sham, pilfered, distorted works which do but muddle the minds of students."

THALES OF MILETUS, IONIA—THALETIS MILESII—one of the "seven wise men of Greece" (the others being Solon, Chilo, Pittacus, Bias, Clenbolus and Periander) founder of the Ionic philosophy and from whose school came Socrates, is said to have been the first to observe the electricity developed by friction in amber. Thales has already been mentioned notably at Aristotle and Parmenides, and, in the last chapter of his fifth book, Gilbert says: "We are told by Aristotle in Book I, *De Anima* that Thales deemed the loadstone to be animate, a part of the animate mother earth and her beloved offspring. He considered it endowed with a sort of life, because it possesses the power of moving and attracting iron." Elsewhere he says: "Thales ascribed to the loadstone a soul, for it is incited, directed and moved in a circle by a force that is entire in the whole and entire in each part, and because it seems most nearly to resemble a soul. For the power of self movement seems to betoken a soul, and the supernal bodies, which we call celestial, as it were divine, are by some regarded as animated because that they move with wondrous regularity."

PERIGRINUS' "EPISTOLA DE MAGNETE."

By the courtesy of Professor Silvanus P. Thompson we are here able to reproduce a folio of the famous "Epistola De Magnete" of Perigrinus, now in the Bodelian Library.

PERSONAL.

Mr. G. A. Trube, who has been associated with the British Westinghouse Company since its inception in this country, lastly as Manager of the Engine Sales Department, has just resigned this position to take up the managership of the Société Anonyme Westinghouse of Paris and Le Havre. Mr. Trube, whose address henceforward for all business communications will be 7, Rue de Berlin, Paris, has, in addition to his Westinghouse connections, a host of friends in the engineering world, with whom we gladly associate ourselves in wishing him all success in his new enterprise.

Mr. J. H. Bigland, of the National Telephone Company's London Contract Staff, has been appointed Contract Manager to the Constantinople Telephone Company (Société Anonyme des Telephones de Constantinople), and will shortly proceed to Constantinople to take up his duties.

A NEW SCIENTIFIC REVIEW.

Messrs. Constable & Company, of 10, Orange-street, Leicester-square, London, W.C., will commence the publication in April next of a new quarterly scientific review to be entitled "Bedrock: A quarterly Review of Scientific Thought." The review will appear as an organ devoted to the full discussion of such subjects as the effect on the race of native and foreign disease, of intemperance, of city life and luxury; the fitness of women for government; the real nature of the Psychological and Physiological difference between sexes, races, and classes; the present relation of science to religion; theories of evolution and heredity, the trend of scientific and mechanical research, invention and development; in fact, with all the greater problems of Modern Science, in a manner both fundamentally scientific, and, the editors hope, also generally interesting to an educated public. It will further make a feature of notes on current research work and reviews of selected scientific books. The Editorial Committee consists of Sir Bryan Donkin, F.R.C.P., Professor E. B. Poulton, F.R.S., LL.D., Hope Professor of Zoology in the University of Oxford, Professor H. H. Turner, D.Sc., F.R.S., Savilian Professor of Astronomy in the University of Oxford, and G. Archdall Reid, F.R.S.E. The acting editor will be Mr. H. B. Grylls.

Mr. Allan R. Connal, A.M.I.E.E., M.E., has been appointed Assistant Manager to the National Electric Construction Company, Ltd.

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The Institution of Electrical Engineers.

DYNAMOS FOR MOTOR ROAD VEHICLE LIGHTING.

Discussion on Mr. J. D. Morgan's Paper at the Birmingham Local Section.

In the course of the discussion at the Birmingham Local Section of the I.E.E. on Mr. J. D. Morgan's paper on "Dynamos for Motor Road Vehicle Lighting,"

Mr. L. MURPHY agreed that the subject was one of very live interest and bristling with points for discussion. The author divided the subject into electrically and mechanically regulated devices. Another way which the makers might not adopt was that of dividing them under devices which destroy a battery and those which heated up a clutch. Many of the devices discussed simply provided means for waste for the surplus energy when the engine was running at speeds just higher than necessary for the generation of the voltage required by the lamps. In one case this surplus energy was thrown in the battery and in the other a clutch wasted energy in the form of heat. An excellent output characteristic was the one shown by the C.A.V. machine, of which the curve in Fig. 8 gave the performance. It would be noticed that in this case the generator output did not increase at any speed to an amount much greater than that required by the lamps. This was calling attention in another way to the desirability of not designing the machine for much greater output than that required by the lamps, but it did not follow that the machine would be small for its work, as this would of course result in excessive heating. He did not care for the term "constant torque" and "constant speed" as applied by the author to those clutches, a more correct way would be to call them "torque limiting" and "speed limiting" clutches. With a true constant speed device there would be no problem at all, one would simply have an ordinary shunt-wound or magneto dynamo and leave the constant speed device to do the rest. Mr. Murphy took strong exception to the author, a condemnation of the magnetic machine on Fig. 6. It was not necessary to design these machines in such a way that they demagnetise themselves at all in use, and if the author's statement were correct such machines could never have found their way to the market. A strong point in favour of the magneto generator was its comparatively high efficiency for machines of small output. He very much doubted if any of the electrically excited machines described would have a full-load efficiency of more than 30–35%, and if the output of the dynamo was, say, 150 watts, this would mean a load of ¾ h.p. on the engine. The great disadvantage of the magneto generator was, of course, its weight and bulk, but this was probably not insuperable.

Dr. S. P. SMITH said that after listening to the author's interesting description of the several electrical and mechanical devices that have been proposed or adopted for obtaining constant pressure for motor-car lighting, one was naturally led to wonder if there was not some simpler method of solving the problem. The trouble seemed to arise in the attempt to drive the lighting dynamo from the main engines, the speed of which could not be constant. Surely some attempts must have been made to avoid these complicated contrivances by installing a small auxiliary set for lighting quite independent of the main engines. The advantages of such an arrangement were at once obvious. Thus there would be a larger amount of freedom in the design of the dynamo and the engine driving, and the set could be made to run at the most economical speed and efficiency. Further, the space taken up by such an auxiliary engine would be very small owing to the small output required and since the battery would now be superfluous (except where a reserve was necessary) it was possible that the auxiliary engine might be accommodated in the space thus made free. The efficiency of the dynamo might be considerably improved by using a magneto machine for the working conditions might now be suitable for this type. It would be interesting to have the author's expert opinion on this point and to hear what experiments have been made in that direction.

Mr. R. V. C. BROOK said that with regard to the Bleriot system mentioned by the author which he believed was one of the first practical sets on the market, the constant action of the dynamo pumping surplus current into the battery was very detrimental to the latter, and in a case which had come under his notice the battery was found to be useless after a short time. With reference to magneto dynamos which had been mentioned by previous speakers, he agreed with them that it should be possible to produce a machine of this type suitable for car lighting which would be more efficient than the self-excited type, and should have a fairly long life judging from the performance of the modern ignition magneto which is subject to a rapid frequency demagnetising action which is absent in the car-lighting magneto. Mr. Brook said that the slipping clutch which the author said was quite satisfactory seemed to him to be unmechanical, and unless it was looked after would give trouble owing to the rapid wear. He was of the opinion that the problem of regulation should come under the electrical rather than the mechanical mind, and he believed that the whole subject was one that large electrical manufacturers at least in this country had not gone into deeply but now that the motor-car was becoming so universal, some of our leading electrical firms might take up the matter with the result that a sound, simple and efficient car-lighting set would be produced, which would do away with batteries and other troublesome devices.

Mr. R. G. PORTE did not agree that the battery system was unsuitable, inasmuch as the dynamo had not been sufficiently tested on the heavier type of vehicle. Five years ago he tried a dynamo and found that owing to the excessive vibration to which it was subjected, the result was not satisfactory. He therefore adopted the battery and installed in 100 of the London type buses which in a period of five years travelled over 10 million miles. At present there were 150 buses running in London with that system installed. He need hardly state that the batteries were properly looked after, one set being charged while the other set was in use, the discharged battery being taken off at night and a charged one put in ready for the next day's work. The batteries were of Tudor make and were admirably suited to the work. There were no battery breakdowns, the biggest trouble being lamp renewals. The points to be considered in this class of work were "foolproofness," weight maintenance cost of installation. The cost of the battery system was about ¼ of the dynamo system. In the latter system "foolproofness" had not been seriously considered, weight was increased, and the maintenance was he thought, quite as much, but that remained to be seen. He did not wish to convey that he was averse to the dynamo system, as in pleasure cars, the system was a boon and worked admirably.

Mr. M. A. E. L. MOHARRAM did not think lighting and constant candle-power necessary, and considered that the varying speed of the car might be taken advantage of to supply illumination which varied as the speed. If constant illumination were required, he advocated mechanical coupling of the dynamo to the gear-box in such a way that varying the gear also adjusted the dynamo speed to suit. He did not allow for fogs, which were not experienced in his own country.

Mr. E. WILLIAMSON said he noticed that Mr. Morgan omitted all reference to the permanent magnet machine without any regulating field winding, and he would like to hear his views on the capabilities of such machines and whether the natural disabilities were sufficiently serious to render them inefficient and unserviceable. It was recognised that the output must vary considerably with varying speeds. Could this objection be sufficiently overcome by the use of extra large accumulators or other simple means?

Mr. J. D. MORGAN, replying to the discussion, said with reference to Mr. Murphy's humorous suggestion as to the classificaton of dynamos, that it was only necessary to

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point out that a properly designed electrically regulated machine did not spoil a battery, and a properly designed slipping clutch for mechanical regulation was not subject to serious heating. The suggestion to substitute the terms "torque-limiting" and "speed-limiting" in terms "constant torque" and "constant speed" devices was good and had been previously considered by the author, who had decided that it was preferable to employ terms which, though they might be slightly inaccurate or not very clear, were in current use amongst those who had to employ the terms. Regarding permanent magnet machines it was very hard to obtain any reliable information, and the author had not succeeded in obtaining any machine for testing purposes. It appeared to be generally accepted that magnetos were subject to rapid weakening of the field and consequently a machine which when new was constructed to give a certain output at a certain speed would be found to be unable to maintain the output after a short period of use on the road. It might be argued that this was not experienced with magnetos for igniting purposes, but it must be pointed out in these machines the maintenance of a constant output was not of serious importance provided sufficient energy to produce a spark could be obtained and the field could be weakened considerably without serious result. A slight weakening in a magneto for lighting purposes would probably render it quite useless. It was admitted, however, that magnetos provided a very attractive alternative, and if it was found that they were not subject to deterioration they would be very useful for car-lighting purposes, especially when a speed controlling switch was used. Mr. Murphy's suggestion that electrically excited machines have a full-load efficiency of not more than 35% was inaccurate.

With reference to Dr. Smith's suggestion that a small auxiliary not driven from an independent engine might be used for motor car lighting had already been considered by more than one well-known engineer, and it was felt by several who had given attention to the subject that eventually the dynamo might probably be driven by a small separate engine.

Mr. Moharram's suggestion that a constant brightness of the lamps was not necessary was by no means new, for it had been more than once advocated as a virtue that the lamps increase in brightness with the speed by makers who have tried to make a properly regulated system and failed. A little experience of motoring at night was sufficient to convince anyone that uniform brightness of the lamps was essential. A moment's reflection would show the impracticability of trying to get constant speed in a dynamo by any connection with the ordinary change speed gear-box.

Replying to Mr. Williamson's question as to whether the output from a permanent magnet machine not fitted with any regulating devices could be maintained sufficiently constant by the use of an extra large accumulator, the author had not tried this with permanent magnet machines, but he had tried it on a machine excited from a battery and having an extra large accumulator arranged in parallel with the lighting circuit. It was found that some degree of regulation could be obtained in this way, but it was not sufficiently good for practical purposes.

APPLICATION OF ELECTRIC MOTORS.*

By M. Shuttleworth.

The object of this paper is to attempt to point out some of the main considerations which have to be borne in mind when applying motors to everyday use.

At the outset the choice as to whether direct or alternating current should be used is generally limited by the nature of the supply. Both systems undoubtedly have advantages, and where a choice of system is possible the exact nature of the work which the motor will be called upon to do will have to be carefully considered.

The direct-current motor is always handicapped by its commutator and brushgear, which must work under good conditions if maintenance and upkeep are not to be excessive; but in cases where a variable speed is required the direct-current motor will be found to be extremely useful, as by the use of a simple and comparatively cheap regulator, placed in the shunt winding, a speed variation of 6 to 1 can easily be obtained, and that at a good efficiency. In connection with this question of speed regulation, it is well to bear in mind that when a motor is only occasionally required to run at a slow speed, the installation of a resistance placed in the line circuit is worth considering, as this allows a smaller and therefore cheaper motor to be employed.

Turning to the alternating current motor, one is at once struck by its simplicity and robustness, due to there being either no moving contacts or only slip rings with low potential between them. It also has the further advantage of being able to withstand heavy overloads for short spaces of time, but the great difficulty of efficient speed regulator with this type of motor is sometimes a disadvantage. The method usually adopted is to use a wound rotor and insert resistance to obtain the required speed; apart from the bad efficiency obtained by this method, it has the further disadvantage that any change in load with a given amount of resistance in the rotor circuit, results in a variation of the speed.

Many attempts have been made from time to time to bring out some satisfactory variable speed device, and in the case where only two definite speeds are required, it may be found advisable to use a specially constructed motor wound in such a manner that by changing the numbers of poles the two speeds can be obtained; a motor of this description is not very efficient, and naturally somewhat costly. A device has now been put upon the market to get over this difficulty of speed regulation; it is the outcome of the use of two motors joined mechanically together, which when on the high speed are both connected in parallel to the mains, but when the speed is required to be reduced, the rotor slip rings of one motor are connected to the stator of the other. Somewhat similar characteristics have now been combined in a single motor by the use of a special stator and rotor winding. With this motor, two or three efficient speeds can be obtained, with further variation of speeds by means of rheostatic control in the stator winding. One is also enabled with this motor to change from one speed to another without interruption to the supply circuit, which is a great advantage over the ordinary motor with two windings, in which case it is necessary to break the main circuit before changing to the other speed. It is claimed that this cascade motor has all the advantage of the ordinary induction motor, and it appears to have a wide field for certain classes of work.

Mention may also be made of the three-phase commutator motor, the speed of which can be controlled more easily than that of any motor on the market (either D.C. or A.C.), for with this motor no special starting gear is required, the brushes being simply set in a neutral position, and both variation in speed and reversal obtained by merely movements of the brushes. This motor has not found a large application up to the present, probably owing to its "series" characteristic, and to the short time it has been on the market, but there is no doubt that it is eminently suited for such jobs as: hoists, haulages, shears, etc.

The simplest requirements of a motor are to start with light load, and to run at a moderate and constant speed for fairly long periods, and it may be remarked that these conditions cover the majority of cases. Loads of this description are met with in lathes and milling machines in an engineering shop, blowers in a foundry, conveyors and grinding plant in a flour mill, sausage machines and many others. For this class of work a shunt-wound direct-current motor or a squirrel-cage induction motor are both the best and the cheapest.

Machines with similar characteristics to the above, but requiring a high speed, are found in high-pressure blowers and turbine pumps, and should direct-current be used, it is well to bear in mind that a special shunt motor will be required to give good commutation with a weak field. Cases arise in which a high starting torque and constant speed are required, and then a direct-current motor with compound-wound fields, or an alternating-current motor with a wound rotor should be used. Direct-current motors which are frequently started or stopped or have to deal with a very fluctuating load, are always best if compound wound in order that good commutation may be obtained and the cost of maintenance kept down. An alternative,

* Paper read before the Newcastle Local Section.

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which is now largely employed for loads of this description, is the use of motors fitted with interpoles.

For cranes and hoist work the direct-current series motor is nearly always adopted, as for work of this nature a motor is required that exerts its maximum torque at starting. Outside crane work, however, this type of motor does not find a very large application, as the speed is so very variable, it being proportional to the load, and other than for traction work it is not much used.

Alternating-current motors for this work have usually wound rotors, and the high-starting torque is obtained by inserting resistance in the rotor circuit.

Passenger elevators are of much the same class as cranes, but the practice adopted is somewhat different. With direct current, a compound-wound motor is most usually employed in order to avoid the excessive speed obtained at light loads when a series motor is used.

Alternating-current motors for this service are frequently squirrel-cage, provided the horse-power is not great. The motor will be required to be specially designed with a high-resistance rotor in order to obtain a large slip and big torque at starting. The slip is quite often as much as 20%, and motors of this description, if not above 15 h.p., are found to start quite satisfactorily without taking an excessive current; their efficiency is not very good, being only some 70%, but this is even better than a motor with a wound rotor and resistance. A further point in favour of adopting a squirrel-cage motor for this work is the simplicity of the control gear, a plain reversing switch being all that is required. The alternating-current commutator motor described earlier in the paper is also coming in for this class of work.

Before deciding on the type of motor to use for any particular job. it is very necessary to bear in mind the work and general character of the machine which the motor is going to drive. For instance, on any machine with sudden intermittent demands, such as shears and punches, or guillotines in printers' works, it is nearly always possible to use a relatively small motor by including in the mechanism a suitable fly-wheel, and selecting a motor with a series characteristic.

When using direct-current motors in such cases one has the alternative of employing a plain "series" motor or a compound-wound motor with a specially large proportion of series turns. If an alternating-current motor be used, a wound rotor with some form of slip regulator will have to be adopted, or a squirrel-cage motor with a high resistance to give the necessary large slip.

The method adopted for coupling the motor to the machine is a matter of great importance, on account of the effect it has on the life of the motor. This can readily be appreciated when it is remembered that the revolving armature of any motor is made up of a large number of parts, and it is important, therefore, to try and choose some connection which will absorb or nullify any jars or vibrations.

The belt drive most nearly approaches these conditions as it is the best flexible coupling obtainable. The drive is not expensive, up to fairly large horse powers, and if run at fairly economical speed of 4,000 to 5,000 ft. per minute, a considerable life can be obtained.

Under certain circumstances a belt is rather at a disadvantage, for example, in very dusty places, or where subjected to abrupt changes of climate, and when used for very slow speed working, very high stresses are obtained. This is particularly the case where the load is intermittent.

Small pulleys should be avoided whenever possible as a very high belt tension has to be maintained to keep the belt from slipping, and not only the belt but the bearings are likely to suffer by this treatment. The losses are also increased by the slipping that takes place, and the abrupt bending of a belt round a small pulley very much shortens its life.

The ratio between the driving and driven pulleys is influenced to some extent by the distance between their centres, but it is never advisable to exceed a ratio of 6 to 1, and that only in cases of small horse power.

The rope drive is very much on a par with the belt, it is practically always used in multiple and frequently adopted for large horse powers. In cases where one engine is used to transmit power to different floors in a building, it is quite often found that a number of ropes are taken to each floor. One point in favour of the rope drive is that the breaking of one rope causes no stoppage of work. Rope driving is seldom employed other than in multiple, except perhaps for small work.

The toothed chain drive has lately been put to more extended use, partly, no doubt, to better construction. This drive is rather a rigid connection, but it is found extremely useful when the distance between the centres is too short for a belt drive. The cost is rather heavy and the length of drive should be kept short on this account. If the chain is needed to run at a high speed or to work in a dusty place a gear case will be required, which adds further to the cost. The most satisfactory speed will be found to be 1,500 ft. per min., and though this speed is by no means the limit, the wear becomes rather excessive if it is much exceeded.

Chains are best driven in a horizontal position, and when inclined, the driving side is usually put on the top.

Gear and pinion drives find a large field where space is an important item, as the motor can often be placed under the machine it is driving. Large reduction in speed can also be met very well by this method. A safe speed to adopt is about 1,200 ft. per min., but this can be greatly increased by the use of a raw hide pinion, with the additional advantage of less noise.

The gear and pinion drive is of a very rigid character and care should be taken in the manufacture of the motor, as the vibration and hammering of the gears undoubtedly shorten its life.

It is always advisable whenever possible to include a belt between the motor and the machine, as should the machine jam the motor suffers very severely unless the fuses or automatic gear are set light, which is extremely unlikely. The foundation of a motor driven by gears should have special attention, and nothing short of a good concrete foundation should be used as the least vibration sets up wear on the gears, which then commence knocking, with the result that the life of the motor is shortened.

For large powers, double helical machine-cut gears have lately come very much to the front, quite revolutionising the uses of a gear drive in many classes of work. Needless to say, they are expensive, but in spite of that, they are finding a large market on account of their general excellence.

Direct coupling to a machine is best arranged with some form of flexible coupling in order to save the motor as much as possible from jars and shocks. A coupling of this nature also saves any strain on the bearings, which often takes place, due to bad alignment.

The flange coupling is also frequently adopted where the torque required is constant. Such as centrifugal fans, blowers and motor generators. In these cases a rigid coupling of this nature has been found to give every satisfaction.

A motor may be applied either to drive a line of shafting, the drive then being termed a "group" drive, or the motor may drive one particular machine, the drive in this case being known as an "individual" drive. No hard and fast rule can be laid down as to when a group or an individual drive should be adopted, but very nearly every important item can usually be credited to the individual drive, except the important item of first cost, which usually favours the group drive.

It may be stated that the individual drive is correct when :—

1. The cost of the installation is less than for a group drive.
2. The saving in running costs of the individual motor is sufficient to pay the interest on the additional expenditure.
3. Convenience of operation is worth the extra expenditure.

Taking the first consideration—cost of the installation—this usually favours the group drive as one large motor and shafting, provided the machines are near together, is cheaper than the individual drive comprising a lot of small motors, but should the machines be very scattered about the works it is quite likely the individual drive will be the cheaper.

Taking the second consideration—saving in running costs—this depends upon many items :—

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(a) Overall efficiency of the motors.
(b) Number of belts, loose pulleys and bearings which can be eliminated.
(c) The difference in the standing charges.
(d) The hours run each day by each machine, and if one or two machines are frequently required to run overtime this consideration becomes quite an important matter.

The third consideration—convenience of operation—cannot very well be expressed in £ s. d., as can the first two, but it includes such items as : quick and easy control of speed, less noise, steadier speed, cleanliness, better light, freedom from stoppage due to broken belts, saving in space and flexibility in location of machines.

The first two considerations, bearing on the question of the cost, are usually the deciding factor as to whether a group or an individual drive should be used, as the last consideration, although important, cannot as a rule be shown to have a direct pecuniary advantage.

It is found in general that new works, equipped at the outset with electric power, favour the individual drive, as the saving in cost of erecting shafting helps to pay for the additional motors, while works that are already in operation favour a group drive owing to the shafting as a rule being already in position.

A large engine driving the whole of a works is usually handicapped by numerous belts for the transmission of the power from floor to floor, the large amount of space taken up with miscellaneous shafting and complicated gears to drive machines which may be at right angles to the main drive, the numerous and heavy losses in transmission which are relatively larger when only a few machines are in use.

The installation of motors under these conditions usually shows a large saving in cost, provided the motors are installed in an efficient manner, and it is for jobs of this description that a good deal of judgment is required in deciding on the sizes of motors to employ.

Many methods may be adopted, as :—

1. The manufacturer will probably supply information as to the horse-power required to drive his machine ; but except in such cases as pumps and compressors, the performance of which can be guaranteed, their figures should be accepted with caution, it usually being found that a manufacturer underrates the horse-power required.
2. The engine can be indicated at full load and light load and an approximate figure for the nett horse-power required to drive the machines obtained. An error, which is sometimes quite considerable, can creep into this method when assuming the losses at light load to be the same as at full load. This is a point that is not often taken account of, as cases are rarely met with in which the error is large enough to upset calculations.
3. A dynamometer of some form can be used and the torque measured direct. This is a method that is very accurate, but seldom lends itself to application in practice.
4. An electric motor can be used, but apart from the useful and reliable figures obtained, it means a considerable amount of fixing up and there must of necessity be a source of supply on the premises.
5. Calculations can be made from the general data concerning the work to be done.

In practice it is well to use as many methods as possible and check the results obtained by experience and common sense.

DISCUSSION.

Mr. B. A. M. Cooper said : I would like to make a few remarks on the paper. Mr. Shuttleworth mentioned at the start that the simplest requirements of a motor are to stand with light load and to run at a moderate and constant speed for fairly long periods. Is it meant that the load must also be perfectly steady. I take it that it might be any load.

Regarding speed regulation, it is stated in the paper that 6–1 regulation can be obtained on a shunt motor by means of a simple regulator placed in the shunt winding. Is that a simple shunt motor or a compensated one. Is not the speed regulation high at least for a 500 volt motor. By a "good efficiency" do you mean about 88% or lower than that. Motors run for long periods at constant speed even if the load is absolutely steady may, after say a six hours run, be running at a very much higher speed than at the beginning.

Mr. Schuil some time ago gave some particulars of some tests on three different motors after six hours run at full load.

2 h.p. at 1,140 r.p.m. 10·2% speed variation from start to finish.
5 h.p. at 1,420 r.p.m. 2·5% speed variation from start to finish.
30 h.p. at 705 r.p.m. 7·1% speed variation from start to finish.

At the same time the motor speed went up when it was put on light load. Light load speed very much higher than after an hour or two run than at the start.

The reason that I bring this up is that in some cases where motors are used in textile work it is important that the speed should be absolutely constant or the carpets would become irregular and rough. In the same case as the looms you get sometimes all moving together and then out of step when there is very great variation in the load on the low speed. If you can design the shunt field liberally or rocking brushes about even then I do not think it will be a very constant speed.

I saw the record of a 10 h.p. motor working on the looms. In 15 sec. the speed varied between 18% to 3% according to whether the looms were in step or out of step. This was a plain shunt motor. The differential pinion is alright if the variation is slow as there is a certain amount of time lag due to the induction between the series and the shunt coil. Siemens have a motor for driving a lift of which I got particulars from another paper. The motor is 100 b.h.p. with a speed variation of 100–600 r.p.m., commutator pole compensating winding quite suitable for giving 100% overload in all speeds. The efficiency at 100 r.p.m. is 80·5%, and at 600 r.p.m. is 85·5%. The maximum efficiency at a speed of 300 r.p.m. is 88%. This is a very good performance for a plain shunt wound motor. I do not think these were the motors Mr. Shuttleworth was referring to for long speeds. For textile work plain shunt wound motors are hardly good enough. As a matter of fact, the supply in the districts where most of the textile work is done is nearly all A.C., and, therefore, they do not have to trouble about D.C. motors.

Mr. Christainson said : Mr. Shuttleworth refers to a three-phase commutator motor. I have heard of a single-phase commutator motor, but I am not quite clear about the three-phase one. Can Mr. Shuttleworth give us any information with regard to the principle of induction motors used for fairly heavy driving fitted with reversing switch, and the effect of reversing them with the motor running.

Mr. Woodward said : Speaking of A.C. motors, Mr. Shuttleworth has not made any mention of asynchronous motors. Probably because they require to a certain extent skilled attendants to look after them. In special cases they are used in textile work and in the case of small motors.

Then in the case of the single cascade motor with special rotor and stator windings, I wonder if he can give us a little more information regarding connections.

Trouble is sometimes caused by consumers replacing fuses by very heavy wire. In fact, I believe there is a case on record where a fuse was replaced by a hairpin.

Mr. E. Wyatt said : Mr. Shuttleworth mentioned that constant speed motors sometimes are required with a very high starting torque and D.C. motors with compound-wound fields should be used. Do you mean to cut out the compound windings when the motor gets up speed, or is the compound winding reversed when running.

Mr. H. A. Browett said : In Mr. Mountain's lecture last week a case was stated in which a motor was put in only about half the size it should have been. Mr. Shuttleworth mentions this matter in his paper. This just seems to be a case in point. Single-phase motor with series characteristic. Should it be single-phase shunt machines used for driving sausage machines, I should have thought that series motor would be used as it has a "serious" characteristic.

Mr. E. G. Townshend said : Might I ask Mr. Shuttleworth why electric drills never seem to be satisfactory. Is it on account of the control gear ? What does he think would be the idea of a control for electric drills. You want to be able to go fast and then perhaps very slowly. When tapping a hole it is necessary to go slowly or the tap will break. What

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I have seen appear to have very inefficient control gear and consequently do not work properly.

Mr. SMITH said: My experience with small motors is very slight. I have, however, had a little experience with motors in textile works, and in that respect I entirely agree with Mr. Shuttleworth that, if possible, individual drive is best. Grouped drive is sometimes indulged in, but, if possible, and in all new installations individual drive is put in. Mr. Shuttleworth mentioned three reasons, but a fourth is that much better work is turned out, and more of it. In long shafting a considerable amount of oscillation takes place, and this oscillation plays havoc with the textile fabric, especially in spinning. In several mills an increase has been got out through having individual drive on the machines. In one case 180 small motors were installed. This may seem a lot, and undoubtedly the first cost was rather high, but I believe the owners are perfectly satisfied with the job, one advantage of the motors being that they are all alike (they are 1½ h.p. squirrel-cage motors) and, therefore, only one or two spares are kept in stock. It is a German job, and I think the British manufacturers may take a lesson from them. They are all standardised, but I think the British manufacturers are too desirous of pleasing everybody.

My experience with D.C. motors is very small, but I think A.C. squirrel-cage motors are far superior.

Mr. SOUTHALL said: I have been very much interested in this paper. The card calling the meeting stated that the paper was on "The application of small electric motors." The paper, however, is equally applicable to the largest drive we could think of. Some mention has been made of the three-phase commutator motor. There are not many of this type in England at present, due probably to their having been brought out by a continental firm. I think there is a considerable future before it. Some speaker said he had heard of the single-phase commutator motor. The first type of three-phase commutator motor brought out was two single-phase motors mounted on one shaft with the stators connected something like the system of connecting three-phase to two-phase. Instead of using two motors now, however, another type has been brought out where you have just one commutator to the motor. The motor has a commutator at one end and the brushes on the commutator are connected to series transformers in the line. A little consideration will show that both your rotor and your stator will have a rotating field and therefore by fixing your brushes so that the two rotating fields can run together, the commutators have no tendency to rotate and therefore to stop the motor all that is necessary is to bring the brushes into position, whilst to start the motor it is only necessary to move the brushes slightly and you displace one field, and, of course, the rotor field tries to catch up. These motors are being adopted for hoists and winding engines and make a very satisfactory job. There are a very large number of electric winding engines on the Continent fitted with this type of motor. You see you can get any speed you like from standing to full speed, the only operation required being just to move the brushes over the commutator. Reversing is obtained by merely turning the brushes round the other way so that all that is necessary to alter the speed or reverse positions is to pull the lever one way or another.

Then Mr. Woodward mentioned the asynchronous A. C. motor. This motor has been put on the market which will do instead of ordinary induction motor. The motor is fitted with single-phase rotor and is started up in the ordinary way. When up to speed the rotor is changed over on to exciter, which is in the same field, and I believe has given very satisfactory results. I saw one of these motors running at a place in Yorkshire. It was running on a turbine blower at 3,000 r.p.m. off these people's own supply. They had a number of slow speed motors with big clearances which run at a big power factor. The generator they had driving these motors was nearly always loaded with wattless current. The turbine was nothing like loaded, but the generator was practically fully loaded when they put this blower on with a self-starting asynchronous motor, and when this blower is running the load in amps., is less than when it is shut down, although an extra 200 h.p. had been put on. Mr. Shuttleworth mentioned the question of the arrangement of drives. I do not think that we can place too much importance upon that, for that is very often where the success or failure of an installation often comes in. Mr. Shuttleworth also mentions the group drive and the individual drive, but very often the question is not between a purely individual or group drive, but some machines are to be grouped together and there are others to be put on separate motors, and the exact arrangement of which machines should be put on individual motors, and which should be lumped together, often makes the difference between success and failure.

Mr. BAXTER said: I have one or two points to raise in connection with Mr. Shuttleworth's paper. He mentions a regulation of 6–1. I have had some experience in designing shunt machines some six years ago for battleships in the Japanese Navy, and the trouble we had was that we got the 6–1 regulation, but the motors were exceedingly noisy on the low speeds, and that is a drawback in motors with large ranges of regulation. Mr. Shuttleworth mentions for occasional speed variation it might be good enough to use a line resistance. That is all right so long as the occasional speed variation is a reduction, but what will he do if he wants an increase in speed. He is forced to go to a machine for shunt regulation. He does not seem to think much of the system of changing the speed of an induction motor by changing the number of poles. I must say that with Mr. Cooper I am not clear as to what is in Mr. Shuttleworth's mind when he talks about a machine being started up light and then running at a reasonable load for a certain length of time, because my experience has been that motors are the most abused sort of machine that one can get. Motors are put on all sorts of duty. Manufacturers who sell motors have a great tendency to instal control gear suitable for starting up light only. That is usually a mistake, even in such a simple thing as a sausage machine it might happen that the machine is full and then how can it be started up light. Mr. Shuttleworth mentioned that outside of cranes and similar work there is not much field for series motors, but these are admirable for driving variable speed fans when combined with a grouping switch which enables the field to be thrown in series, series parallel, or all in parallel. I am sorry I have not had more time or I could have got you a curve showing the speed variation, and the variation in the amount of power delivered, but I will say that it works remarkably well. You get a large drop in speed, of course, from the first change, but at the same time it works efficiently, and seems to give very little trouble. Regarding the speed of belts, surely Mr. Shuttleworth has made a mistake when he says that leather belts are run at a speed of 5,750 ft. per min.; why, that is nearly a mile per minute. Personally, I would not like to stand in the line of fire when the belt is running at that speed. With regard to helical gears, I think that one of the great advantages is the numerous ratios one can get without getting hold of gears which wear badly. Mr. Mountain mentioned a case of 30–1 reduction, and one would certainly require to have a double reduction.

Mr. BILLINGTON said: I would like to agree with Mr. Shuttleworth about the group drive. I have not had much experience, but it may be of interest to you to know that in a shop where I was working there were about 40 to 50 machines, and the shafting was grouped into about 6 or 8 lengths, and this worked very satisfactorily. On one machine the motor was replaced by a chain driven one. On this particular machine there was considerable amount of vibration, but the motor worked satisfactorily, and the chain drive was never touched from one year's end to the other except to oil occasionally, and they have never given trouble.

Mr. WYATT: Mr. Shuttleworth mentioned the cascade connection of the motor connecting the rotor of the one to the stator of the other. Is there not another way of doing this, by connecting the two rotors together, and for the lower speed short circuiting one? You connect the rotating field of the second one to the stator winding. I do not know whether this is so, but I believe there is some method of doing it that way.

Mr. CHRISTEN: Mr. Shuttleworth has dealt very fully with the various types of motor, but this has been looked at from a consumer's point of view only. There is, however, another person to be considered, namely, the supply company. It may not be the case on the north-east coast, where the supply companies are large, but to small companies it may be a very serious matter when a consumer puts in a motor which takes a very large starting current, or works at a bad power factor. With regard to direct current, it is a very common thing, especially with small

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motors, for the first step of the starter to be out of all proportion to the others. Otherwise reliable manufacturers seem to take no care in the design of small starters, and instead of arranging them in a uniform way for a maximum of, say, 100% overload current, the first step very often goes up to about 500%. To what extent must the supply company be consulted before such a thing is installed. In the case of alternating current motors small companies very often prohibit their use unless the power factor is ·8.

Mr. CRAVEN: I agree with Mr. Shuttleworth regarding the replacement of fuses. An instance came to my notice about a month ago where a motor driving a cinematograph in a picture hall, 10 h.p., 500 volts, supposed to take 6 amperes, and the fuses had been replaced by 2/18 copper wires.

Mr. CLATWORTHY: Mr. Shuttleworth mentioned about a simple and comparatively cheap regulator being placed in the shunt winding of a motor. The difficulty I have found very often with motors is in telling beforehand how much resistance would be required. You can only calculate approximately and then when you come to test the machine you may be 50% or even 60% out. It is always far safer to wait until you have tested your machine. With regard to cascade motors, I have never seen one of these motors at work, but I think the cost militates against their use very largely. They cost about 100% more than the ordinary type of the same h.p. Regarding the driving of turbine pumps by shunt wound electric motors. Some of you will have had experience and will know that it is an important thing that motors of this kind should be equipped with a shunt regulator on account of the difference in speed when the motor is hot or cold. You must run the pumps on a very uniform speed in order that they may deliver the water. As a rule, a motor when cold runs rather slower than when it is hot, so that the shunt regulator is to be inserted when the motor starts, and withdrawn when the motor warms up. Regarding motors for driving elevators, I think it is the general practice to cut out the series turns when once the motor is started and brought up to speed, and some makers are using a shunt wound motor. The subject of brakes is not touched upon in the paper, but it is a very important part of the equipment. In the paper it says that before deciding upon the type of motor to be used for any particular job it is very necessary to bear in mind the work and general character of the machine it is going to drive. This is extremely important, and one has sometimes to watch a machine for hours before an insight into the character of the machine is obtained to enable you to decide upon the type of motor to be used. Mr. Shuttleworth mentions the belt as being a good flexible coupling. I quite agree with him, but I have seen some machines where the speed is varied regularly about 50% up and down by simply slipping the belt from the fast tothe loose pulley as required. The belt speed mentioned of four to five thousand feet per minute is undoubtedly a very high speed, and it is very rough indeed on the belt. If you do not work with a very tight belt the centrifugal force neutralises the advantage of the high speed. Another point is regarding small pulleys being fitted. I quite agree that it is not always easy to put in as large a pulley as one would like to. With small pulleys, however, the thickness of the belt is an important point. I came across a job the other day where some pulleys were used, and the consulting engineer specified double leather belts. Friction drive is a drive in certain cases which I think is extremely useful, especially in small motors, and even with ratios of 1–10 and 1–12 they are working satisfactorily. Regarding the question of rapid driving with belts the speed often runs up to six or seven thousand feet per minute. Single belts are very frequently used in mill drives running at different speeds. One point about chain drive I would like to mention is that it is of the greatest importance that the chains should be very carefully fitted, that is, the motor should be absolutely parallel with the machine it is going to drive, otherwise the wear becomes excessive, and the chain is worn out in three or four months. Gear and pinion drive appears to be satisfactory, but a great amount of care should be taken in the manufacture of the gear. Regarding the foundation, it is exceedingly important that where a motor has to be gear driven if at all possible I think a bracket should be made and bolted to the machine itself so that the whole is in one case. Then double helical gears are mentioned. Some firms say that 30–1 reduction is quite practicable. I have in one or two cases taken out spur wheel drives, which when running at 3,500 r.p.m. were noisy and those double helical wheels have worked very quietly indeed. With regard to flexible couplings between motors and machines, these take up the difference in alignment to a certain extent, but it is very important, nevertheless, that one should see that the two shafts are as nearly in line as possible. Even by being only about 1-16th of an inch out of line leather belts are sometimes torn to pieces in something less than a week. Another advantage which can be claimed for individual drive is that a good many architects consider that the building may be a good deal lighter. It is very difficult in practice to go by the belt speed or by the size of the pulley, as makers are usually very liberal in the size of belts and pulleys.

Mr. SHUTTLEWORTH, in reply, said: There seems to be some point which wants clearing up regarding the simplest requirements of a motor. This is simply taken as an ideal case, and is about the easiest condition possible for a motor, and I think the meaning has been misconstrued. There were some interesting points raised regarding three-phase commutator motors and the cascade motor. Mr. Southall very ably replied regarding the three-phase commutator motor, but there was one point which may not have been covered by what he said, and that is that the voltage of the commutator is comparatively small, due, of course, to the series transformer. Regarding the cascade motor, it is certainly quite complicated. The ordinary induction motor is usually regarded as a transformer, of which the stator, of course, is the primary. In the cascade motor, the windings of the stator is in parallel. These are divided into sections, with the result that you really get two fields in your machine. It is by reason of these two fields that you are enabled to put a resistance in the stator coils to get your different speeds between what may be called efficient speed. There are two or three efficient speeds with cascade motors, and these are obtained by changing the number of poles in the rotor and not in the stator, as is generally done. It certainly is a motor which seems to be coming in to a certain extent, but there is no doubt that it is more costly than an ordinary motor, but I hardly think it is as high as 100%. Another point raised with regard to these cascade motors, not so much the new motors which have lately come out, but the previous arrangements, and I think there have been all sorts of arrangements of connecting two motors together to get efficient speeds. There also seems to have been a good deal of question about the 6–1 speed deviation, but it is quite a simple matter to get a motor in which you can get that regulation. Regarding the question of trouble on the low speeds owing to noise, I should think that if it were only occasionally required they might adopt a line resistance which has already been mentioned in the paper. A gentleman made a remark about the deviation in speed of motors when the load of the motor was constantly fluctuating. If you have a properly designed motor with the fields in opposition instead of working together there ought to be no difficulty about the speed being within 3 to 5%, and if that is not so it is a question of being badly designed. Another point was raised about the various starting conditions of induction motors. It is no doubt quite useful for small pumps, but, personally, I think the compensated type is the best. You can certainly get more range with a compensated type. With regard to the remarks about the sausage machine, I will give this matter "serious" consideration in the future. Electric drills are very interesting, but no doubt one of the difficulties is that you have to get the motor into a very small space. A motor with a very high speed is used and the only regulator which seems at all useful is a resistance in the line, owing to the fact that if you had a shunt regulator, at the low speeds you would require a much larger motor. The remarks Mr. Smith made about textile factories were certainly extremely interesting, and no doubt the induction motor is the thing in that class of work. Apart from the regulation in speed, which seems to be very fine, you have got commutator and brushes. I was interested in the remarks about the small pulleys and the thickness of belts. There is no doubt that very often one is up against a great diffi-

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culty, especially in small work. How often with the different proportions not being able to close with the job is the cause of a man sometimes not going to the expense of a specially slow speed motor, and then one has to go to larger ratios in driving and hence very often smaller pulleys are used than are necessary. A high resistance induction motor for lift work with an efficiency of 70% and the gentleman who made that remark said he thought that the rotor wound motor would have a better efficiency. I think he will find that the high resistance motor is much better, 50% efficiency is quite usual with a wound rotor. I was interested in the remarks made regarding chain drive not being looked at for a long time, but I think it should certainly be looked at at intervals.

The application of asynchronous motors in general practice is not very great.

ELECTRICITY AND THE WATER SUPPLY OF THE WITWATERSRAND.

By D. C. Leitch, M.Inst.C.E.*

The works described in this paper serve an area of 365 square miles, with a population of 139,000 white and 226,000 coloured inhabitants. Seven municipalities and seventy-three mining companies take water from the Board. The Rand lies at a considerable elevation, and divides the streams flowing to the Orange River and the Atlantic from those which flow to the Crocodile River and the Indian Ocean. The gold-bearing conglomerates of the district dip to the south; they are overlaid by volcanic rocks, and still farther south by dolomite, from which the present supply is obtained. The catchment-area of the Klip River valley, above the Board's wells, is about 308 square miles, the average rainfall being 29·5 in. per annum. The Klip River valley has for many years been regarded as a possible source of supply for the Rand; other schemes had been considered, but, owing to various reasons, none passed the preliminary stage. The scheme now described includes reservoirs and distributing-mains on the Rand, and a rising main from Zwartkopjes, where there is a central pumping-station. At this station there is electric generating-plant, and main pumping-engines, the latter delivering the water on the Rand, a single lift of over 820 ft. The former provides current to actuate the pumps at the wells in the vicinity, which include nine pairs of shafts and bore-holes in an area of about 50 square miles; these pumps raise the water from underground and deliver it at the pumping-station at Zwartkopjes. The supply is obtained from fifteen shafts and five bore-holes, sunk, with two exceptions, in pairs, the units forming a pair 110 ft. apart. In most cases bore-holes were sunk in the first instance from the level of standing water, and sometimes yielded an adequate supply; in other cases a shaft was sunk and headings were driven, using the permanent pumping-plant to keep down the water. The total supply available is about 7⅓ million gallons daily. Headings were driven by native labour to intersect water-bearing fissures, where these were not met with in shafts, and all bore-holes were torpedoed to improve the yield of water.

The central pumping-station at Zwartkopjes contains the steam-driven pumps, boilers and superheaters. There are four sets of main triple-expansion pumping-engines, which are of the vertical inverted type, driving the pump-plungers direct off crossheads. The maximum capacity of each engine is 100,000 gallons per hour, against 960 ft. head. There are three high-speed electric generating-sets, each of 360 kw., supplying three-phase current at 3,300 volts. On trial, with a superheat of 500° F., the main engines consumed 11·25 lbs. of steam per net horse-power hour, a record performance; in ordinary working this consumption is increased to about 13 lbs. Current is delivered to motors at the wells at the full voltage of 3,300 to 3,000, by overhead transmission-lines of stranded copper, carried on timber cross-arms and steel poles, which also carry telephone-lines. The well-pumps are of the bucket-and-plunger type, driven by rods and bell-cranks from a head-gear and motor placed centrally between each pair of pumps. The fly-wheels, on crank-shafts of the head-gears, weigh about 4 tons each, and a considerable saving in cost was effected by constructing them of reinforced concrete from material on the spot. The capacity of the pumps ranges from 45,000 to 8,000 gallons per hour. These electric motors are connected to the head-gear by double-reduction spur-gearing. Six of the motors are of 50 b.h.p. and four of 75 b.h.p. each; the overall efficiency of motor, gear, and pumps is about 70%.

The water pumped from Zwartkopjes to the summit at Turffontein Nek, gravitates to the pumping station at Village Main Reef. Here, up to 100,000 gallons per hour can be pumped to Yeoville Reservoir, against a head of 270 ft.; of the remainder, part is taken by mining consumers before reaching Village Main Reef, and the balance is distributed east and west along the Rand. To accelerate the delivery eastward, steam-pumping plant, capable of delivering 200,000 gallons hourly against a head of 80 ft. is provided. The pumping engines are of the Worthington duplex, triple-expansion type, with pneumatic compensators, driving the high-lift pumps direct off the crossheads and the low-lift pumps off the tail-rods of the high-pressure plungers; the latter pumps can be readily connected or disconnected. There are also several small electrically-driven pumping stations, drawing supplies, in all about 500,000 gallons daily, from wells. The rising main from Zwartkopjes is constructed of 27-inch and 29-inch welded steel pipes, with both riveted and Kimberley collar joints. As the maximum head may reach 960 ft., the lower portion of the pipe is strengthened by steel-wire binding. The length from Zwartkopjes to the summit is about 6½ miles, divided into four sections by reflux valves of special construction for high pressures. Expansion-joints are provided, and the pipes are protected by a bituminous coating; precautions are also taken against sand cutting. The leakage amounts to only 150 gallons per hour. The distribution system is then described, comprising 133 miles of steel mains, averaging 14½ inches in diameter. Provision is made against subsidence over mine-workings. The storage reservoirs on the Rand have a total capacity of about 10 million gallons. In addition there are settling tanks at Zwartkopjes, with a total capacity of 6,070,000 gallons, and also two clear-water tanks, each containing 75,000 gallons. These tanks are all uncovered, and are constructed of reinforced concrete. The whole of the water delivered to consumers is measured.

The average hardness of the Zwartkopjes supply is about 19 parts per 100,000. This is reduced to 14 parts by the addition of hydrate of lime, a solution of which is added to the water entering the settling tanks from the wells. As much as two parts of iron per million is found in the water from some of the wells which afford the most copious yield. Growth of weed is prevented in these cases by adding one part in three millions of copper sulphate; while the oxide, formed as soon as the water is aerated, is removed by passage through a cinder filter. Owing to the occasional presence in summer of *B. Coli*, probably due to insect sources, it is desirable to have means of sterilizing the water. This is done by the addition of 7½ to 15 lbs. of chloride of lime per million gallons.

The works described were carried out mainly by local contractors, under the direction of the author, material being purchased in England under separate contracts. The total cost was about £900,000.

Particulars are given of the working of the plant and the cost of dealing with the water. Thus, during the first half of 1910, the difference between the water pumped and water sold was about 6·2 per cent. on a total of 172 million gallons per month, and with about 10¼ million gallons in circulation, in mains and reservoirs. During the second half of 1910, the average demand rose to 235 gallons per month, and the cost of pumping and delivering water to the consumers was 7½d. per 1,000 gallons. Adding to this fixed charges on Rand water stock—paid by direct contribution from the municipalities and producing mines—which amounted to 1s. 4·84d., the total cost of water was 2s. 0·34d. per 1,000 gallons.

* Abstract of a paper read before the Institution of Civil Engineers, February 6, 1912.

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Technical Problems and their Solution.

QUESTIONS AND ANSWERS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways, and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for the next best, but in the case of two replies adjudged to be of equal merit, these two sums may be added together and divided. Replies should reach the office within seven days of the appearance of the questions.

QUESTIONS.

Problem No. 1272.—On a three-phase circuit of shaft cables there are two pumps; one a turbine the other a three-throw. Starting up the three-throw causes a wattmeter coupled to one phase (balanced load) to revolve in its correct direction. Starting the turbine one now causes the disc to slow down, stop, and revolve in the opposite direction. Turbine works at half normal head. Pressure coil of wattmeter is connected to a potential transformer phase to neutral.—" P. F."

Problem No. 1273.—A revolving-field alternator with direct-coupled exciter, driven by a direct-coupled steam engine is to supply a 90 b.h.p. 6-pole constant speed induction motor; the system being three-phase, 750 volts, 40 cycles. As the motor would start only twice a day, it is proposed to use a squirrel-cage motor connecting it to the alternator through a protective device, without any special starting apparatus; the motor to be started by running up the generating set. The alternator has average characteristics and the motor would have :—Speed 783 r.p.m., efficiency 92% and power factor 93% at full load. No-load current 12 amps, and stand-still current 302 amps. (at a power factor of 23·4%) per phase. Ratio of transformation 8·6. Stator star connected; resistance hot ·182 ohms per phase. Show the relation between torque of the motor and voltage, current, frequency, and power factor at starting; also state any objections to the scheme.—" SQUIRREL-CAGE."

Problem No. 1274.—A potentiometer resistance is required to have 50 steps and an ohmic resistance of 400. It must be stepped out in such a way that the shunt field rises in equal increments of currents, while the difference in the potential drop between the first and second step and that of the two last must not be excessive. The line voltage is 440, resistance of shunt say 400 ohms. Shunt current 1·1 to 0 amperes.

ANSWERS.

Problem No. 1271.—Explain—with theoretical justification—a method of measuring fault resistances, applicable to 3-phase or 2-phase 3-wire networks. Simplicity is important.—" QUERIST."

Reply to No. 1271 (*awarded* 10*s.*).—In dealing with such low resistances as are met in electric light and power cables one has to adopt a means for measuring and localising faults, in which the actual resistances of the cables concerned are not taken into account, since with ordinary apparatus these are not easily found to any accuracy; moreover, the resistance of the fault may be many times that of the cable.

Two methods of comparison are applicable: the Murray Loop Test and the Fall of Potential Method, and in each case we simply compare deflections or resistances.

Fall of Potential Method.—In this the faulty cable is isolated and connected up as shown in Fig. 1 to a battery of ignition accumulators or a bank of lamps from the electric light mains. The current is adjusted until a large scale deflection is obtained on the millivoltmeter, and it will involve less calculation if a resistance is provided so that when testing from other end the current may be kept same as first test. Referring to the figure again, we have :—

l_1 = length of fault from testing end A.
l_2 = length of fault from testing end B.
E_1 = reading obtained on millivoltmeter at end A.
E_2 = reading obtained on millivoltmeter at end B.

then :—$E_1 = C_1 \times l_1$ and $E_2 = C_2 \times l_2$; and if the current is same at both tests :

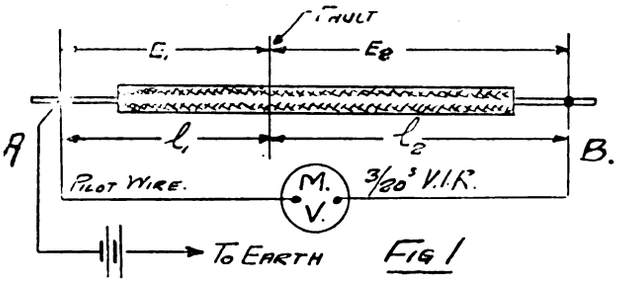

FIG 1

$$\frac{E_2}{E_1} = \frac{l_2}{l_1} \text{ and } \frac{E_2 + E_1}{E_1} = \frac{l_2 + l_1}{l_1}$$

so that $l_1 = \frac{l_2 + l_1}{E_2 + E_1} \times E_1$

that is length of fault from end A

$$= \frac{\text{total length of cable}}{E_2 + E_1} \times E_1$$

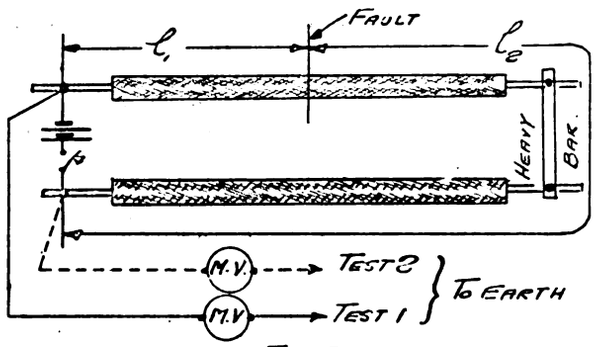

FIG 2.

In the above method the testing current is sent *through* the fault, and mention may be made of a second way in which this is not the case, and since the resistance of the fault enters into the millivoltmeter circuit a very high resistance galvo. is used, such as in a Kelvin testing set, so that the fault resistance may be neglected. Fig. 2 shows diagram of connections, and as before we have :

$E_1 = C_1 \times l_1$ and $E_2 = C_2 \times l_2$, so that the length of the

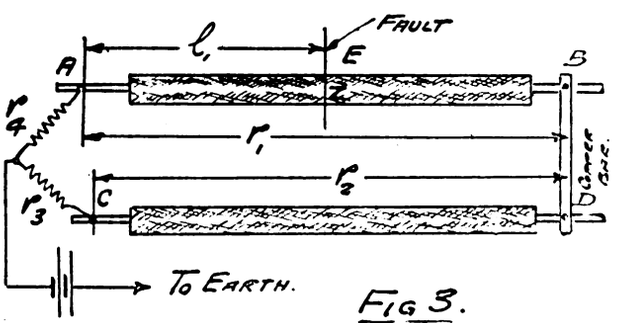

FIG 3.

fault from testing end $= \frac{\text{total length of cable}}{E_2 + E_1} \times E_1$

and in this case the currents are the same at each test.

Murray Loop Test.—This method is adopted where the resistance of the fault varies and a steady current is impossible. It is really a Wheatstone bridge, and in place of the P.O. box we have a slide wire resistance. The " loop "

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is formed of a healthy cable preferably of same area and length, but if this is not possible it involves merely a little more calculation.

Fig. 3 shows the connections. As before a current of 1 or 2 amps. is sent through the system from an ignition battery or a bank of lamps, and the slide wire is adjusted until on depressing the galvo. key no deflection is obtained.

Points A and C are now at the same potential, and it follows that :—

$$\frac{P_3}{P_4} = \frac{CD + BZ}{AZ} \text{ or } \frac{P_3 + P_4}{P_4} = \frac{CD + (BZ+AZ)}{AZ}$$

$$\text{i.e., } \frac{P_3 + P_4}{P_4} = \frac{P_1 + P_2}{l_1}$$

$$\text{and } l_1 = \frac{P_4}{P_3 + P_4} \times (P_1 + P_2)$$

The slide wire is of constance section throughout and we can therefore substitute lengths for resistances ; similarly, if the pilot cable is of equal section to the faulty cable we can put length for resistance and we have :—

Length of fault from testing end

$$= \frac{\text{length of } P_4}{\text{length of } P_3 + \text{length of } P_4} \times \left\{ \begin{matrix} \text{length of faulty cable} \\ + \\ \text{length of pilot cable.} \end{matrix} \right.$$

I have endeavoured to make the explanation as simple as possible, and " Querist " will see that these methods are well suited to three and four-core cables, where one of the cores can be used as pilot wire, and especially with armoured cables where a good " earth " is readily obtained.

The results obtained are generally correct to a yard or so, but before opening ground it is well to check results and if possible test from each end and take the mean of the distances.—G. M. B.

STEAM TURBINES UTILISING THE IMPULSE PRINCIPLE, WITH SPECIAL REFERENCE TO THE DISC AND DRUM TYPE.*

By T. R. Houston and F. G. Parnell.

The distinction between the Impulse and Reaction principles may be summarised thus :—

In an Impulse turbine the steam expands through nozzles, thereby gaining considerable velocity. The jet of steam is directed against the moving blades, work being performed leaving the steam with axial velocity only. The drop of steam pressure takes place entirely in the nozzles, the pressure across the blades being constant.

In the Reaction turbine, however, the principle is essentially different, although the steam attains its velocity in exactly the same manner.

If we imagine steam expanding through a nozzle which is capable of rotation about an axis, then, as the steam tends to radiate equally in all directions from the centre of pressure, the nozzle will be subjected to a force which will move it in the opposite direction to the steam. This is the fundamental Reaction turbine. In the modern turbine of the Reaction type, the steam expands in the fixed blades, gaining sufficient velocity to meet the moving blades without shock, expanding in these again till the velocity is nil relatively to the casing, and thus driving the rotor by reaction.

It is evident that this principle is very different to the Impulse principle, as the former drives the blades or nozzles in the opposite direction to the steam, whilst the latter drives them in the same direction.

The Reaction principle is theoretically the more efficient, but owing to the short and therefore inefficient blades necessary in the high pressure stages, the Impulse principle is found to be more efficient for this portion of the expansion.

It is therefore an obvious development to employ Impulse blading for the initial expansion, Reaction blading being adopted to full advantage in the later stages. This combination constitutes the Impulse-Reaction or Disc and Drum turbine. It is usual on these machines to " compound for velocity," as it is termed ; that is, the velocity energy of the steam is not all taken out in the first impact, but the steam is guided by means of a row of fixed blades on to a second row of moving blades. This must not be confused with the Reaction principle, as there is practically no difference of pressure over the whole set of blades.

The usual type of Impulse-Reaction turbine consists of a set of nozzles from which the steam impinges on the Impulse blading arranged round the periphery of a steel disc. This disc is somewhat larger in diameter than the first stage of the Reaction blading into which the steam is now passed. The steam now continues its expansion in the Reaction blading, and passes to the condenser. Approximately half the energy of the steam is taken out in the Impulse wheel and the remainder in the Reaction blading.

This construction not only conduces to increased efficiency, but as the Impulse disc is so much shorter than the Reaction blading for the high pressure stages, a great saving in space is effected.

Impulse Turbines.

The following are the four chief types :—

De Laval.—This is of the ordinary impulse form, the energy of the steam being converted into kinetic energy in one stage. The jet of steam is directed from divergent nozzles on to blades giving up its energy and being brought to rest. There is only one ring of blades. Owing to the very high velocity attained by the steam and the consequent high peripheral blade speeds, this turbine cannot be direct-coupled to a dynamo. A reduction gearing of about 10 to 1 is usual. That this is necessary may be gathered from the fact that these machines run at a speed, in some cases, of as much as 30,000 revs. per min. Of course, at this speed, special balancing devices are needed, the essential feature being the De Laval flexible shaft.

Rateau.—In this turbine the steam partially expands in a row of nozzles and is directed against a row of moving blades, giving up its kinetic energy and leaving the steam with axial velocity only. It then passes into a second set of nozzles and again expands, giving up its energy in part to another row of moving blades. This process is continued till the energy of the steam is exhausted, as far as possible between the existing temperature limits, when it enters the condenser.

The *Zoelly* turbine is similar to the above but has fewer stages and therefore higher blade velocities.

Curtis.—This turbine is similar to the Rateau inasmuch as the steam is expanded in several velocity stages, but, unlike the Rateau, each stage is " compounded for velocity " in the manner previously described.

* Abstract of the paper read before the Northampton Institute Engineering Society, on February 2. Mr. C. E. Larard, M.I.M.E., A.M.I.C.E., in the chair.

Correspondence.

All communications intended for the Editor should be addressed " The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

"PRACTICAL NOTES ON INDUCTION MOTORS."

To the Editor of the Electrical Engineer.

Sir,—In reply to " W.H.B.'s " letter in the current issue of the Electrical Engineer, I must apologise for the rather ambiguous wording of the sentence he names. The idea which I meant to convey was that " for large feeders supplying a considerable number of induction motors it is distinctly better practice to use several small conductors in parallel instead of one large cable." This, however, is not of much practical importance for conductors smaller than ·380 B.W.G.

Trusting that this explanation will clear the matter up for " W.H.B." and others.

John S. Leese.

February 2, 1912.

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PROTECTIVE DEVICES REQUIRED UNDER THE NEW MINING RULES.

Of all the discussion which has, during the last few months been raging around the proposed new rules for the use of electricity in mines, the question of the protective devices to be provided has probably aroused more interest and criticism than anything else. Accordingly, now that a number of amendments have been introduced and the rules finally approved in their new form, it may be of interest to see what provision Messrs. Everett, Edgcumbe & Company, whose leakage indicators for such work are now so well known, have made for bringing their instruments into line with the new requirements.

It will be remembered that this firm were the first to attack the problem seriously when the 1905 rules came out. It was said in many quarters that it was impossible to comply with the rules, but under the expert guidance of Mr. F. C. Raphael, Messrs. Everett, Edgcumbe & Company introduced a full set of leakage indicators for every system, which complied completely with the Home Office requirements. These instruments have since then been considerably improved on, from time to time, and have been found so useful for colliery work that their installation has become common for above ground plants.

Accordingly, when under the new recommendations of the Joint Committee, it was proposed to do away with leakage indicators, and to substitute leakage relays, which were intended to cut off the supply in the event of a considerable leak, there was an outcry among colliery engineers, and as a result, the leakage indicator is again called for as heretofore.

Taking the new rules in order, as far as the question of protective devices is concerned, we have :—

Rule 7. In order to comply with Sections a and b, the recommendation of the Committee runs as follows :

> An ohm-meter should be available at every mine at which electricity is in use, and care should be taken to choose an instrument which will give accurate readings on all apparatus, including cables. There should also be available at every mine where alternating current is in use a portable testing transformer suitable for giving a number of voltages, the maximum to be not less than twice the highest working pressure in use at the mine. This apparatus can be used where on account of the high pressure an ohm-meter would be unsuitable.

Messrs. Everett, Edgcumbe & Company have a well-known form of ohm-meter which is particularly suitable for this purpose. They have also introduced a compact form of testing transformer, giving the various ranges called for.

In connection with Section c, which deals with the earthing of the system and with various other clauses which insist on the absolute necessity of keeping earth plates in thorough order, the earth plate testing set, devised by Messrs. Everett, Edgcumbe & Company, will be found invaluable.

Section d deals with the leakage indicators already mentioned and lays down that an indicator is to be provided for showing at once any defect in the insulation of the system.

FIG. 1.

This requirement is similar to that which existed in the old rules and was, we believe, originally due to a suggestion made by Mr. W. C. Mountain as the result of his experience in colliery work. It may be added that Messrs. Everett, Edgcumbe & Company have devoted an enormous amount of attention to this particular question and have developed no less than 24 distinct varieties of instrument suitable for every class of installation, whether for high, low, or medium tension. Fig. 1 shows an instrument suitable for the former, and Fig. 2 one suitable for the latter.

FIG. 2.

In connection with Section d, as originally drafted in the proposed new rules, the Committee recommended that any leakage of current should be made not only to be indicated on a dial, but to actually trip the circuit breaker and thus cut off the supply from either a part or the whole of the affected area. It was pointed out by various witnesses before the Committee that this would actually lead to more trouble than it was likely to prevent, since, in the first place, the engineer-in-charge would be given no indication whatever of the state of his mains until a bad fault occurred; and, in the second place, when such a fault did occur, the mine would be plunged in darkness and all motors would be stopped. The Committee recognised the force of these arguments and under the rules as actually issued it is merely laid down that circuit breakers with or without relays should be provided which would cut off the supply in the event of a short circuit, as is, of course, common practice whether in mines or above ground. They also, as has been said, laid down that leakage indicators were to be provided. It has been suggested that it might be possible to instal an instrument which, on being touched by a workman would cut off the supply (in fact, an instrument has been placed on the market for this purpose), but it is easy to show that the current necessary to actuate such an instrument is far in excess of that required to seriously injure, if not to kill, anyone through whom it passed. Such devices, therefore, besides being extremely delicate, give a false idea of security which is to be deprecated.

When once it is shown by the leakage indicator that there is a fault on one of the phases (the instrument gives an indication not only of which phase is faulty, but also whether the fault is a bad one or not); it is necessary for

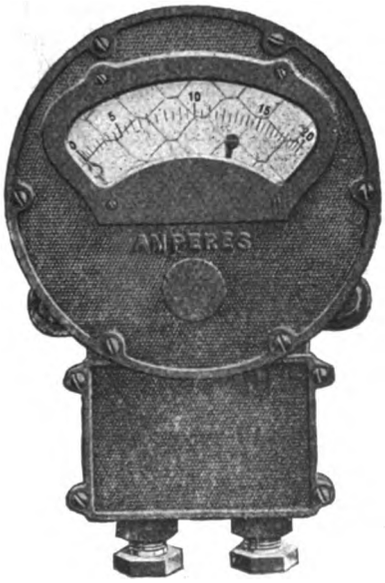

FIG. 3.

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the engineer to locate its position and for this purpose various instruments, based on the loop test or fall of potential method for direct current, and on the induction method for alternating current, have been introduced by Messrs. Everett, Edgcumbe & Company.

Under Rule 8, it is stipulated that all switch or fuse covers and instrument cases are to be connected to earth, and this requirement necessarily entails a special form of instrument, where an ammeter is required. It may be mentioned in this connection that colliery engineers were quite unanimous in their recommendation that ammeters should be installed with each motor, their main contention being, that such an instrument affords an indication of anything being wrong with the motor, thereby often preventing a bad breakdown which, in a mine, may be a very serious matter. This conclusion, it may be remembered coincides with what has been the standard practice in the Admiralty for some years, viz., to provide an ammeter on each motor (in the case of a battleship, some 100 in number). Messrs. Everett, Edgcumbe & Company were led to develop a special water-tight instrument for Admiralty requirements, which has been largely used for mining work, with

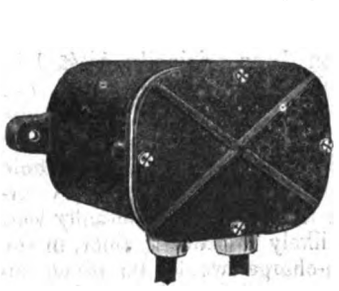

FIG. 4.

FIG. 5.

one or two small modifications. The instrument is shown in Fig. 3, and among its special features may be mentioned the glands for leading the cable in and out, the water-tight terminal box at the bottom of the instrument and, above all, the fact that the winding is in an entirely separate compartment from the movement so that if, as very often unfortunately happens the glass of the instrument is broken, no damp can find its way to the winding and the insulation is, therefore, unimpaired. This latter is a most important consideration and one which has been largely overlooked in the past and has been responsible, probably, for more breakdowns of ammeters than anything else. It may be added, as showing that the water-tightness of these instruments is actual, and not merely supposed, that in accordance with the Admiralty specification, each instrument is tested under a 3 ft. head of water before being passed.

Rule 9 calls for the protection of the low tension side of transformers and for this purpose, where it is not convenient to earth the winding, Messrs. Everett, Edgcumbe & Company have introduced a special form of spark gap illustrated in Fig. 4. This consists of two small cylinders separated by a narrow air gap and mounted on porcelain in a cast-iron case. One of these spark gaps is connected between each pole of the transformer and the earth, so that should the high tension current find its way into the low tension winding, owing to a fault between primary and secondary, a short circuit occurs which blows the primary fuses, at once cutting out the faulty transformer.

Rule 11, Section a, calls for lightning arresters to be installed wherever required and, as will be readily recognised, collieries, which have often a considerable length of overhead conductors, and are usually in exposed positions are particularly liable to disturbances from lightning. Fig 5 shows a very compact form of lightning arrester suitable for systems between 1,000 and 6,000 volts, and Messrs. Everett, Edgcumbe & Company also supply horn type of arresters for use out of doors or in stations, either connected direct to earth, or, as is strongly recommended in series with a Brazil Powder Lightning Arrester Resistance.

Section c calls for the cutting off of the supply from the affected part of a system in the event of a fault, as already mentioned, but, as has been said, this is nothing more than is every day practice whether above or below ground.

Altogether it may be said that the New Mining Rules although possibly erring on the side of caution are, in the main, distinctly satisfactory, and under the guidance of such a firm as Messrs. Everett, Edgcumbe & Company, the colliery manager need have no fear as regards complying with them, at any rate, as far as protective devices are concerned.

THE TURBINE OUTLOOK.

Whether or not we may look in the near future to any revolutionary developments in respect of the generation of electricity is still a moot point with engineers on this side of the Atlantic. The new Tesla turbine seems to indicate something of the kind, but until it becomes commercially practicable little that is definite can be said about it. Dr. Tesla's paper on the subject in the middle of the year (which was transmitted to the ELECTRICAL ENGINEER) was certainly a startling indication of progress in a new direction, and his later demonstrations of his discovery added enormously to the interest of the situation. But as a whole, engineers are sceptical, at any rate on this side, and prefer to wait until the promised demonstration in the spring of the present year before pronouncing an opinion. The Chicago journal, dealing with the turbine situation, observes that the growing uses of electricity in the generation of which turbo-generators are particularly serviceable, as well as the replacement of steam engines in other than electric generating plants, have resulted in an almost extraordinary development of steam-turbine use in all classes of these machines. "It has been estimated," it says, "that the aggregate rating of the steam turbines now in service is upwards of 20,000,000 h.p., most of which has been installed in the last few years." Only one incident in the passing of the steam engine need be mentioned. A few months ago the famous Corliss engine, which was one of the wonders of the Centennial Exposition at Philadelphia in 1876, was sold for scrap. One of the most striking developments in the past year was the successful completion and placing in service of the largest prime mover ever built. This is the 20,000 kw. vertical Curtis turbo-generator at the Waterside station of the New York Edison Company. Several similar units are going into this station and into the new Northwest station of the Commonwealth Edison Company, Chicago. Although this event is a great achievement of the turbo-building art, still further advances in capacity are contemplated. The prophecy has been made that within a few years the central-station interests in our largest cities will demand turbine units of 25,000 kw. rating and possibly even much greater. The horizontal turbine has been preferred for all sizes except those over 10,000 kw. The builders of horizontal machines stand ready, however, to build such units up to any desired capacity. Through the further development of a successful high-power reduction gear, the steam turbine has been adapted to the driving of large direct-current generators, something which had already been successfully done with small machines of this type. There has been a tendency to employ higher speeds in some types of large steam turbines, 1,500 and 1,800 revolution-per-minute machines being now built up to the 10,000 kw. size. The economies in both fixed and operating costs attainable by the use of very large turbine-driven generating sets are being sought by many of the largest electric railway systems in the principal American cities, such as the Boston Elevated Railway Company, for example. This company is installing two 15,000 kw. turbo-generators in a station that will ultimately contain over 100,000 kw. in similar machines. The reliability of these units is so high that it is perfectly safe to concentrate all the power production in one highly economical station which supplies a number of rotary-converter sub-stations to take the place of former scattered engine-driven power plants. Another field for the steam turbine is being developed as the result of the perfection of the so-called "bleeder" type of turbine. This has an automatic valve between the intermediate and low-pressure stages which permits some steam to be diverted or "bled" from the turbine for auxiliary purposes or heating systems. This makes a very economical and flexible unit for combined electric and central heating plants. Very much more extensive use is also being made of small re-entry type impulse turbines in size from 1 to 300 kw. for operating power-plant auxiliaries.

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THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION.

Proceedings at the Annual General Meeting.

The annual general meeting of the British Electrical and Allied Manufacturers' Association (Incorporated) was held at the offices, 36, Kingsway, London, W.C., on Thursday last. About 50 members were present, and Mr. F. H. Nalder, Chairman of the Council, took the chair.

Before moving the adoption of the report and balance-sheet to September 30, 1911, the chairman referred briefly to the work of the reorganisation of the Association, which, he said, had necessarily occupied much of the time and attention of the Council during the period under review. Members could see before them, in the room where they were sitting, a small part of the results attained. They now had offices and a staff which, he thought, could be regarded as worthy of the industry and of the Association representing it. They had to thank the retiring Council as a whole for that work. Their time and energies had been freely given to it. But it could not have been done at all without the support of the great body of manufacturers, and in the necessary work of putting before manufacturers the advantages of possessing such an Association, no one had done better service with greater success than his friend, Mr. Longbottom (Electromotors, Ltd.), the vice-chairman of the Council. As a result of their efforts, whereas a couple of years ago they had 40 members, they had last year doubled the number, and now the list was but a few units short of a hundred, and steadily increasing. They were not going to stop at that. To make the Association a thoroughly strong organisation, they needed every electrical manufacturer and his allies, and they expected and invited the whole industry to come in.

The other subject which had made inroads upon the energies of the Council and the work of the Association was the Electrical Exhibition promoted by themselves and held at Olympia during September and October last year. That exhibition had certainly been a financial success. He believed the report referred to the good-tempered if severe criticism levelled at it by the Press. They would profit by what had been said, and he hoped their next exhibition would be an improvement in every way. While on that subject, and in view of the members wishing to raise the question, he might say that the Association had for some time found it necessary to set its face against the lavish promotion of exhibitions. The industry had been almost submerged with applications from all sorts of people for support for all sorts of schemes, and had in the past even spent a great deal of time and money without adequate return. They did not discountenance large and creditable undertakings promoted by such people as the supply authorities; and one such exhibition—the forthcoming Smoke-Abatement Exhibition—they were recommending those of their members who were specially interested, to support. Considering the activity of the gas interests and the public interest in the smoke-abatement question, they could not afford to neglect such exhibitions. The secretary would make a statement in this connection.

Turning to the internal business of the Association, he would particularly like to refer to the work of the Sections, into which, for better division of labour, the Association was divided, and within which the main work of the Association was carried on. He said that members who took part in those Sections would appreciate the value of the work done in them. Their proceedings were not for general publication.

Equitable conditions of contract was another important subject which had long occupied their attention; and the Institution of Electrical Engineers had given them an opportunity of submitting proposals in regard to the Model General Conditions of Contract, of which they had availed themselves, and they would shortly be in a position to lay their suggestions before the Parliamentary Committee to the Institution.

The subject of electrical standards was also engaging their attention. He must not, however, occupy their time with a detailed catalogue of what had been done and what still remained to be done before they could feel they had fully vindicated their position. Members would, no doubt, wish to raise some questions on the Report and Accounts. They would notice that a somewhat small balance had been carried forward from the period preceding the re-organisation. They were now, as might be gathered, and he was happy to say, in a very different financial position. He moved the adoption of the report. The motion was seconded by Mr. Longbottom.

Mr. Justus Eck (Union Electric Company, Ltd.) expressed the hope that in the final distribution of the exhibition surplus, the Electrical Trades Benevolent Institution would benefit.

On the motion of Mr. A. B. Anderson (Ferranti, Ltd.) the matter was referred to the new Council.

On the invitation of the chairman, the meeting then proceeded to the election of the Council, and the result of the ballot was declared as follows:—

COUNCIL, 1912.

Belliss & Morcom, Ltd.
British Thomson-Houston Company, Ltd.
British Westinghouse Electric and Manufacturing Company, Ltd.
Browett, Lindley & Company, Ltd.
Dick, Kerr & Company, Ltd.
D.P. Battery Company, Ltd.
Electromotors, Ltd.
Elliott Brothers.
Ferranti, Ltd.
General Electric Company, Ltd.
Lancashire Dynamo and Motor Company, Ltd.
Nalder Bros. and Thompson, Ltd.
Siemens Bros. Dynamo Works, Ltd.
Vickers, Ltd.
Willans and Robinson, Ltd.

After the election of Messrs. Price, Waterhouse & Company as auditors for the year, the secretary stated that arrangements had been made between the supply authorities and the manufacturers for a joint exhibit at the forthcoming Smoke-Abatement Exhibition, on conditions more favourable to the latter than had hitherto existed. A meeting of manufacturers specially interested in lighting, heating and cooking apparatus would be called at an early date to go into the business, and he expressed the hope that any manufacturers of such apparatus still outside the Association would make it their business to communicate with him.

The secretary then dealt at some length with the Sectional and other activities of the Association, and a vote of thanks to the chairman for his work during the year, proposed by Mr. Anderson, having been carried unanimously, the proceedings terminated.

The Council of the Association have fixed Thursday next for their first meeting.

EDISON BATTERIES IN RAILWAY SERVICE.

The visit of Mr. Edison to Chicago made manifest the fact that negotiations are under way with the Illinois Central Railroad, whereby the latter will receive and make thorough tests of three motor cars propelled by storage batteries of the Edison type, in its suburban service at Chicago. It is understood that the cars will be delivered to the road at an early date. The experiments with them will be made in the hope that the storage battery cars will prove to be practical equipment for the smokeless operation of the Illinois Central's suburban service. The Chicago Great Western announced a few weeks ago that it would shortly test out some storage battery cars of the Edison-Beach type, such as have been in use on the Long Island Railroad. The equipment now mentioned in connection with the Illinois Central is said to be an improvement over the present Edison-Beach car, in that the batteries will be capable of re-charging in one hour or less. The quickest time practicable at present is about four hours. The Chicago Great Western car will be operated on the Waverly Iowa, branch, 22 miles in length.

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PHYSICAL SOCIETY OF LONDON.

An exhibition of a Direct Reading Instrument for Submarine Cable and other Calculations was given by Mr. R. Appleyard, Prof. H. L. Callendar, F.R.S., President, in the chair.

The logarithmic spiral has frequently been used for determining by a graphic method the logarithm of the ratio of two quantities. In acoustics, for example, it has been of service as a convenient means of demonstrating the way in which "frequency" is associated with "interval." If an attempt is made to apply the spiral to the solution of practical engineering problems, such as arise in the design of submarine cables, there is difficulty in obtaining sufficient accuracy, especially for readings near the pole of the spiral. The author has removed this defect by introducing a secondary spiral, similar in all respects to the primary spiral, and having the same pole, but displaced round the pole through a certain constant angle. In this instrument a pair of radial scales, each having its zero at the pole, and each divided into the same number of equal divisions, can be rotated about the pole. At all angular positions a scale of this kind will be cut by the two spirals if they are sufficiently extended. It has been proved by the author that for all angular positions of such a radial scale the distance between the pole and the point where that radial scale is cut by the secondary spiral is always the same multiple of the distance between the pole and the point where the radial scale is cut by the primary spiral. In effect, therefore, the secondary spiral magnifies the radial scale readings of the primary spiral to any desired extent, depending only upon the angle through which the template of the primary spiral is rotated to form the secondary spiral. In the instrument exhibited the spirals are drawn in a manner that avoids ambiguous readings, and that gives maximum precision within the range of diameters of conductors and dielectric coverings required for submarine cable work. The instrument is provided with two similarly divided radial scales, one corresponding to d, the diameter of the conductor, and the other corresponding to D, the diameter of the dielectric. The angle between the two scales, corresponding to any pair of values of d and D, is then a measure of $\log \frac{D}{d}$. The scales can be marked to indicate weights of conductor and dielectric, and the circle of degrees to which the spiral is drawn can be marked to indicate $\log \frac{D}{d}$, capacity, dielectric resistance, and other functions of D and d, if required, for any definite dielectric, the specific constants of which are known.

The general equation to the spiral may be written

$$\theta = A \log d + B,$$

where A and B are constants. Hence, when d_{min} and D_{max} are both on the 0 deg. radius vector, any two points d, D on the spiral are associated with their corresponding angles θ_d θ_D in degrees by the three equations

$$\theta_d = A \log \frac{d}{d_{min}}, \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$\theta_D A \log \frac{D}{D_{max}} + 360,$$

$$A = \frac{360}{\log \frac{D_{max}}{d_{min}}}$$

To draw the secondary spiral, the primary spiral is rotated backwards about its pole through an angle ϕ. This is equivalent to rotating both the radial scales through ϕ. The intercepts are now d_1 and D_1—i.e., the radial scale readings are now greater in the ratio

$$n = \frac{d_1}{d} = \frac{D_1}{D}.$$ Equation (1) then becomes

$$\theta_d + \phi = A \log \frac{d_1}{d_{min}} \quad \ldots\ldots\ldots\ldots \quad (2)$$

Substracting (1) from (2)

$$\phi = A \log \frac{d_1}{d} = A \log n,$$

which gives ϕ for any required magnification n.

Discussion.

Prof. S. P. Thompson remarked on the useful applications of the instrument, and asked if it would be possible to make it up in a cylindrical form instead on a plane.

Dr. A. Russell pointed out the large number of calculations in which the logarithm of the ratio of two quantities occur.

The Author, in reply, thought it would be rather difficult to apply the instrument to a cylinder. In cable calculations he used it for finding the capacity and dielectric resistance per mile. By clamping the radial arms and rotating them, an infinite number of values for the diameter of the conductor and the insulation could be picked out that would give the same capacity and dielectric resistance per mile and therefore the same speed of signalling.

A paper on "The Vibration Galvanometer and its Applications to Inductance Bridges" was read by Mr. S. Butterworth.

Vibration galvanometers are divided into two types according as their moving parts possess only one or an infinite number of degrees of freedom. A theory of the former type of galvanometer when used in circuits containing inductance and capacity is completely worked out and the conditions of maximum sensibility are determined.

The same theory is shown to be applicable to the string type of galvanometer provided that the damping is small. The effect of harmonics is also considered in this case.

The results are applied in the case of a general inductance bridge which includes: (a) Anderson's bridge, (b) a modified Rimington's bridge, (c) Heydweiller's modification of the Carey-Foster bridge, and (d) a bridge for measuring frequency.

The best conditions for working Anderson's bridge with the vibration galvanometer as detector are obtained.

Experimental results for methods (b) and (d) are quoted, the latter method being used to calibrate a Duddell vibration galvanometer for frequency.

Discussion.

Mr. A. Campbell pointed out that though the current sensitivity could be increased by decreasing the damping, the voltage sensitivity was not affected as the effective resistance was thereby increased. The voltage sensitivity was also independent of the control couple and the inertia of the moving system.

Mr. W. Duddell said that vibration galvanometers might be looked upon as alternate-current motors, and to be efficient must be capable of producing a strong back E.M.F.

Dr. A. Russell pointed out that for high frequencies the assumption that the damping was proportional to the velocity might introduce errors into the calculation.

ELECTRIC RAILWAYS IN AMERICA.

According to the "Electric Railway Journal," it states, in statistics published in its new year's issue, that a total of 1191·58 miles of new electric railway track was built in the United States and Canada during the year 1911. This compares with 1397·26 miles reported in 1910, 887·16 miles in 1909, and 1258·51 miles in 1908. California furnished the largest new mileage of any state, 120·23 miles; North Carolina was second with 104 miles, and Illinois a close third with 103·96 miles. The California list was largely made up of new lines of the Pacific Electric Railway, around Los Angeles, amounting to 65 miles, and 40 miles of track in Oakland and vicinity electrified this year by the Southern Pacific Company. This is not new construction, but is properly classed as new electric road. The largest part of the new mileage of North Carolina is represented by 94 miles of the Piedmont and Northern Lines. New equipment ordered by electric railways in 1911 totalled 4,015 cars of all classes. This is a decrease of 1,466 cars, as compared with 1910. Of the total cars ordered 2,884 were city passenger cars, 626 interurban passenger cars, and 505 freight and miscellaneous.

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Electrical Progress at Home and Abroad.

UNITED KINGDOM.

Lighting, Power, Telegraph, Telephone, and General Business Notes.

BRISTOL.—The Corporation discussed a report of the Electricity Committee recommending that the salary of Mr. H. Faraday Proctor, electrical engineer, be increased from £800 to £850, and those of Mr. C. M. Davis, publicity engineer, and Mr. A. J. Ostler, sub-station superintendent, £156 to £175 each case. The claims of the electrical engineer were supported by Alderman Pearson and Mr. A. E. Thomas. Mr. Whitefield moved that Mr. Proctor's name be deleted from the list, and Mr. Cambridge seconded. It was recognised that Mr. Proctor is a very valuable officer, but it was contended that £800 per annum is an adequate salary for the appointment. Mr. Witty contended that the financial position of the electrical undertaking does not justify an increase, and Alderman Parsons appealed to the House to consider the position of the poorer ratepayers of the city, who found a great difficulty in making both ends meet. Alderman Parsons also entered a protest against the growing tendency on the part of members to abstain from voting on occasions of this kind, and reminded them that it was their duty to vote. The amendment of Mr. Whitefield was carried by 35 votes to 32. The other two increases were sanctioned.

COVENTRY.—The Corporation have decided to carry out further extensions of their electrical undertaking at a cost of upwards of £16,000.

GLASGOW.—A conference of rating authorities, of whom about fifty were present, was held in the City Chambers, under the chairmanship of Lord Provost Stevenson, to consider the effect on the local rates of the transfer of the telephone undertaking to the Government. The Lord Provost said he believed that the telephone system would increase tenfold in the lifetime of men present. It would be absurd, therefore, for local authorities to accept a stereotyped rate on the present valuation. He thought they should reaffirm the resolution they had previously passed. Another question involved was the loss of rent from wayleaves, which in the case of Edinburgh amounted to £1,649 per annum, and in Dundee to £1,104. On the motion of ex-Provost Keith, Hamilton, seconded by Bailie Nelson, Glasgow, the following resolution was unanimously adopted:—"That this meeting affirms the principle that, until the whole basis of local rating is revised, the Government telephone undertaking should be subject to contributions in lieu of rates based upon the actual valuation thereof as appearing annually in the valuation roll." The meeting also resolved to take steps to obtain an interview with the Postmaster-General and the Treasury with the view of submitting the matter to them, and that the clerks of the various local authorities should communicate with members of Parliament, asking them to use their influence in regard to the matter.

NORTH BERWICK.—At a meeting of property owners convened to discuss the electric lighting of the town, Mr. J. C. Ivens, representing Messrs. Crompton & Company, gave details regarding the cost and a general outline of the proposed installation. It was shown that Messrs. Crompton and Company had entered into an agreement with the Town Council authorising the introduction of electric lighting, and that it was now proposed to float a company in connection with the undertaking. Particulars were given for the purpose of comparison of the expense and results of similar undertakings in ten towns of varying population, and the estimate afforded was favourable to North Berwick. Mr. J. Gairdner suggested that if the proposals met with approval a committee should be formed in North Berwick to further the scheme for the introduction of the electric light into the burgh.

SUNDERLAND.—The estimate of the Electricity Committee submitted for the year ending March 31, sets out a credit balance on the year's working of £5,006 4s. 11d., as compared with a profit of £1,194 3s. 8d. in the preceding year. The total expenditure is estimated at £55,269. In 1911 it was actually £54,059 4s. The principal increase in the outlay is the cost of generating electricity, which amounts to £1,063. This has been brought about by the increase in the consumption of coal, the bill under that head being £8,204 as compared with £7,375 in the previous year. The extra output of electricity accounts for the increased item for coal. So far as revenue is concerned, it is estimated that it will amount to £60,275, against £55,253 in 1911. The revenue from power supplied shows an increase of £4,712, the total charges under that head having been £29,668. Private lighting showed a decrease of £308, and was accountable for a revenue of £15,095. The decrease in receipts under this head is attributable to a reduction in price made by the Corporation in December, 1910, and at the same time the output for this purpose has increased. Increase in profit on the year's working is set out at £3,812, and this is due to economy in working and an increased output.

TAUNTON.—Mr. T. C. Ekin held a Local Government inquiry into the application of the Corporation for sanction to borrow £2,500 in connection with the electricity undertaking. A statement showing the progress of the electricity works from 1894 to the present time indicated that the number of units used for private lighting had increased from 60,537 in 1894 to 272,408 at present. Mr. A. J. Howard, the borough electrical engineer, said that practically the whole of the town is lighted by electricity. The quantity of electricity supplied was increasing at the rate of £425 per annum, which made another battery necessary. There was no opposition to the application.

TEIGNMOUTH.—The scheme for supplying the town with electric light has again been discussed at a special meeting of the Urban Council, and in view of the Council's present available borrowing powers, has been abandoned for the present.

WALTHAMSTOW.—At a meeting of the Urban District Council a report of the Lighting Committee was adopted which recommended that application be made to the Local Government Board for sanction to borrow £22,624 for the provision of additional plant for the generating station. Councillor Turner, in moving the adoption of the report, said that only 48 authorities equalled or beat their output, and only 14 companies equalled them. Only three Councils in a position like Walthamstow turned out the same number of units as they did. Since 1905 they had been too much under-equipped, and they had been running at the danger line. Mr. Spurr, the engineer, had been asked what the requirements were, and he had presented a private and confidential report which had been agreed to by the Council. At the present time the Engineer might be under the alternative of either shutting off the trams or stopping power to consumers. Both alternatives would be disastrous to the town. Their demands were growing, and there was every probability of them increasing. By these extensions they would be able to supply current regularly to both the private consumers and large factories. Further extensions would not be needed for several years, and the cost of laying new cables would not be a high one. They would supply current at a cheap rate so that no electric companies would try to come into the district to compete with the Council. Factory owners were on the look-out for places where current was cheap. More factories would mean increased rateable value, and shopkeepers would reap the advantage of there being more people to spend money.

TRACTION NOTES.

FLEETWOOD.—At Manchester Assize Court, before Vice-Chancellor Leigh-Clare, the Fleetwood Estate Company brought an action against the Blackpool and Fleetwood Tramroad Company, raising the question of the rights of the parties in regard to certain land adjacent to the tramroad of the defendant company. Mr. Grant, K.C., for the plaintiffs, explained that the idea of a tramroad between Blackpool and Fleetwood originated about 1895, and a number of gentlemen formed a syndicate for the purpose of carrying it into effect. In 1896 a Bill for the purpose was passed by Parliament. Meanwhile negotiations were carried

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on with the owners of the Thornton Estate, which has since become the property of the plaintiffs, and an agreement was entered into which gave the owners certain rights. The tramroad was eventually constructed, not according to the line originally contemplated, and the result was that on the western side of the line were portions of land which formed part of the Thornton Estate. The plaintiffs' contention was that the right of the defendants was limited to an easement for a line of railway 30 ft. in width, and that they had no rights over portions of land outside those limits. The defendants said their easement extended to the western border of the Thornton Estate, which in some places was 65 ft., and at the Cleveleys end tapered away to nothing, the average being 30 ft. The particular Act which led up to the present proceedings was that at a spot where the plaintiffs intended to make a road across the line the defendants had put down a shelter and made an approach to it on the plaintiffs' land, fenced it off, and made a road and footpath. The Vice-Chancellor said he did not think that either the Act of Parliament under which the railway was constructed, or the agreement made with the owners, conferred upon the defendants the right to do what they had done. He therefore gave judgment in favour of the plaintiffs, with costs. The plaintiffs would have leave to move for an injunction if the defendants did not appeal within a month.

HOVE.—The poll of ratepayers on the question of a trackless trolley system resulted in a large majority in favour of the proposal, the figures being 1,753 for and 825 against. At Brighton the polling was 7,329 for and 3,141 against.

RAMSBOTTOM.—The decision of the Council to adopt the trackless tramway system was followed by a petition that a poll of the ratepayers should be taken. The result of the poll was 999 in favour and 407 against, out of a total number of ratepayers of 4,029.

TODMORDEN.—The Sub-Committee of the Town Council which was appointed to investigate the trackless trolley system in use in Bradford and Leeds reported that although they were at first very sceptical as to the suitability of the trackless trolley system for Todmorden, they were now fully satisfied that it was in every way adapted to the town's needs. The cost of running was about sixpence or sixpence-halfpenny per car mile, as compared with thirteenpence per car mile for their motor-omnibuses at present in use. The ease, comfort, silence of runnings, and absence of jerking were remarkable. The report was adopted, and the Council decided to discuss it further in committee.

LANCASHIRE NOTES.

Cheaper Electricity for Liverpool—Report of the City Treasurer and Consulting Engineer.

The report of the City Treasurer of Liverpool and the Consulting Electrical Engineer, which they had been instructed by the Tramways and Electric Power and Lighting Committee to make upon the city electricity undertaking with a view to a reduction in the charge made to consumers, recommends, after an exhaustive examination of the position, that the Committee should consider a reduction in the cost of the supply of private houses on the rateable value system of 2½ per cent. per quarter and one penny per unit " with a view to facilitating the adoption of modern and approved appliances for heating and cooking." For shop lighting and trade uses it is suggested that the rateable value charge should be reduced from 4½ to 3½ per cent. For long hour service it is suggested that the present power rate of £8 per kilowatt per annum and ·5d. per unit be reduced to £6 per kilowatt and ·4d. per unit.

The report states that the capital expended on the Electric Supply Department on December 31, 1911, was £2,154,322, while provision made for the repayment of capital and for depreciation and contingencies amounted in all to £995,025. The Local Government Board loans provide for periods of repayment based on the " life " of the items covered by the loan, but as the supply of electrical energy is relatively a new and progressive business, it is sometimes commercially desirable to replace plant even before the short life which forms the basis of the Local Government Board's regulations has expired, and for this purpose reserve and renewal funds should form part of the financial system of all soundly conducted undertakings. Last year in Liverpool there were sold 37,765,203 units with an income of £265,475. The figures include 15,149,005 units for lighting and power sold for £165,966, and 22,616,198 units sold for tramways for £99,509. The average price received was 1·687d. per unit. Meter rentals produced £3,503, and other minor sources of revenue £1,611, making a total income of £270,589.

The expenditure has been as follows :—

Cost of generation, distribution, and repairs ..	£54,893
Rents, rates and taxes	26,467
Management and special charges	23,295
Interest	62,608
Sinking fund	55,185
Suggested contribution to reserve and renewal accounts	23,141
Suggested contribution in aid of rates	25,000
Total	£270,589

In estimating works' costs all the charges, including payments to the rate fund, are considered. They appear as follows :—

	Pence per unit.
Works, costs, production and distribution and repairs	·349
Rents, rates and taxes	·168
Salaries of staff, office and legal expenses, insurance, new service lines and meters	·148
Interest and sinking fund	·749
Renewal and reserve	·147
Aid of rates	·158
Total	1·71

With regard to works' costs, namely ·349d. per unit, the report states that very little reduction on the cost of production can be anticipated from increased output, as the last published works' costs of the two well-engineered and managed undertakings, which alone have a larger output than Liverpool, namely, Manchester, with an output of 83,308,848 units, and Glasgow, with an output of 40,823,090, somewhat exceed the Liverpool works' costs, where the output is 37,765,203 units. With regard to interest and sinking fund, so long as the committee are able to continue the policy of replacing old plant by modern plant of greater capacity out of the reserve and renewal funds, the cost per unit of this item will decrease with the increased output. A decrease per unit may also be expected in reserve and renewal fund with increased output. It is pointed out that the original generating stations—Paradise-street, Highfield-street, Oldham-place and Lark-lane—are now completely equipped with modern transforming plant of more than twice the output of the old steam plant and that the expenditure required to modernise the Lister-drive No. 1 and Pumpfield stations can be provided out of the funds already accumulated for the purpose. Whether or not the prices charged for electrical energy should be made to cover a contribution to the general rate, in addition to covering all working costs and charges for repayment of capital, is a matter which has been much discussed in connection with electrical undertakings, and strong arguments can be adduced on either side. The matter is one of policy, which, having been settled by the City Council, cannot appropriately be discussed in this report. Probably so long as the contribution is kept within reasonable limits the consumers of electrical energy have no strong grounds for objecting to the charge.

The existing scale of charges includes a flat rate scale for lighting from 3½d. per unit to 2½d., and for power from 2d. to 1d., according to the quantity taken. The maximum demand scale for lighting is a fixed quarterly charge of £2 per kilowatt on maximum demand (as registered by a demand indicator) and 1½d. per unit; and for power £1 per kilowatt on rated capacity of plant installed and ½d. per unit. The rateable value scale of charges is a fixed quarterly charge of 4½ per cent. on the rateable value of the premises and 1d. per unit, with a reduced charge of 3 per cent. for private houses. The consumer has the right to select the scale of charges on which the supply is given, but the report points out that it is not commercially practicable to obtain as high a price for electrical

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energy for power purposes as can be obtained for lighting, but it would be unsound policy to sell for any purpose at a price that did not fairly cover both the cost of production and a reasonable proportion of capital and other charges. Any reduction in price, unless it results in proportionately increased consumption, implies a corresponding reduction in revenue, and in the sums available for reserves and for relief of rates, and in considering such reductions preference will no doubt be given to such as are calculated to increase the consumption of electrical energy by existing consumers, and to extend the number of consumers. The report adds that during the year, as regards the supply for lighting considerable reductions have been secured by many large consumers by the adoption of the rateable value system of charging—a system which also enables the user of power to adopt electric lighting on favourable terms and for the user of lighting to extend its use for power and heating.

It appears that under the present system of charging the sales of electrical energy for power purposes are increasing in a satisfactory manner, the increase for the past three years being :—For 1909 over 1908, 7 per cent. ; for 1910 over 1909, 10 per cent. ; for 1911 over 1910, 30 per cent. Experience shows that in Liverpool the majority of the users are "short hour" users, and that users of power who are able to run their plant at a steady load for a large number of hours per annum are unlikely, under ordinary circumstances, to take a supply from the Corporation, as they are obviously free from many of the costs incidental to a supply given by a local authority under Parliamentary obligations. With private plant the cost of producing electrical energy is limited to actual works costs and supervision. There is also no obligation on the private producer to write off his capital in a limited number of years, or to provide special funds for the renewal of plant. For these reasons, the actual nett cost of production by a private consumer cannot be fairly compared with the price at which the Corporation can sell electrical energy commercially, as the conditions are widely different. On the other hand, the adoption of the Corporation supply relieves the consumer from all stand-by expenses and places at his disposal, for the purposes of his business, the space (often of considerable value) which would be occupied by his own plant, and in addition render unnecessary capital expenditure that he would otherwise have to incur. When these advantages are duly considered, a gradual transfer of consumers to the Corporation supply as the private plant at present in service wears out seems very probable.

This report was discussed at great length by the Committee, and in the end was adopted.

AMERICAN NOTES.

Electrical Developments of the past year—Manufacturers' Busy Time—Half-a-watt per Candle.

From the manufacturers' point of view the electrical year in this country has been a very remarkable one, a large expansion of business having been recorded under almost every head. The largest development has been in connection with dynamos and motors, the estimated value of the sales under this head reaching 80,000,000 dollars as compared with 50,000,000 dollars in 1908, and 75,000,000 dollars in 1910. The next largest expansion has been in the trade in wire, 58,000,000 dollars as against 56,000,000 dollars in 1910, and 42,000,000 dollars in 1908. Telephone apparatus totalled 20,000,000 dollars last year and the same in 1910, as against 15,000,000 in 1908 and 1909, but is not quite so good as 1907, when it figured for 21,000,000 dollars. Incandescent lamps have advanced steadily for the five years, the figures being 10,000,000 dollars in 1907, 11,000,000 dollars in 1908, 14,000,000 dollars in 1909, 17,500,000 dollars in 1910 and 19,000,000 dollars in 1911. Under storage batteries, the increase has been from 6,200,000 dollars in 1907 to 10,000,000 dollars last year, the trade having received a powerful stimulus in the constantly increasing popularity of the electrically propelled automobile. Cables at 13,000,000 dollars show a rise as compared with any year but the "banner year" of 1907, when the total was 18,000,000 dollars. With the increase in the sale of lamps there has been a corresponding increase in the sale of fittings, the rise being from 7,500,000 dollars in 1907 to 12,500,000 dollars in 1911. Turbines, after rising from 7,000,000 dollars in 1908 to 14,000,000 dollars in 1910, declined to 10,000,000 dollars in 1911, but this is the only marked fall in upwards of fifty sections of trade.

Half-a-watt per Candle.

In no direction have the energies of manufacturers resulted in greater progress during the past year than in regard to the development of incandescent lamps, both for high and low candle powers. We have not yet reached the practical stage of the half-watt per candle, but this development has, it is reported, passed the laboratory stage and may be made commercially possible at any moment. Properly speaking, this triumph is one of the achievements of 1911, but it seems that it was not felt desirable to place it on the market until every reasonable condition of manufacture had been fully satisfied. From the latest accounts it would seem that this development will not be introduced to the trade generally until March. In its annual review of the industry, the Chicago "Electrical Review and Western Electrician," observes that the most notable development in the lamp industry in 1911 is the general introduction of wire-type and drawn-wire tungsten lamps; improvements which have removed substantially the last objections to their general employment in place of the low-efficiency incandescent and even arc lamps. The ruggedness of the new lamps is such that breakages have been reduced to almost negligible proportions; this feature alone has added to the tungsten lamps a competitive value that is making heavy inroads on nearly every other illuminant. The large tungsten lamps (250 to 500 watts) have given such a good account of themselves that they have come to be used in many places where incandescents were formerly considered impossible. On the other hand, there is a distinct development now in progress toward low-wattage tungsten lamps for standard voltage, as the result of which competent lamp men predict a general movement toward the adoption of high-efficiency lamps for residential lighting within the next twelve months. Although the sales of carbon incandescent lamps have not as yet diminished, the tungsten-lamp developments, together with the last year's improvements in the metallized-filament lamps, are surely hastening the retirement of the carbon lamp even in those few cases where possibilities of theft or of mechanical breakage from exceptionally severe treatment will not as yet warrant the use of the high-efficiency lamp. Tantalum lamps are still very largely used for direct-current traction service. Even in this field, however, the drawn-wire tungsten lamp is being successfully employed and bids fair to drive tantalums out of their last stronghold. In the older types of arc lamps no very important improvements have been made. The various types of these lamps continue in some demand. There is a decided tendency for their replacement, however, by the more modern and efficient arc, vapour and even tungsten lamps. Magnetite arc lamps have been improved in several details, such as reduction in weight, better design of glass globes, adaptability to decorative street lighting, etc. In the latter respect a notable installation at New Haven, Conn., was recently made in which a unique and compact design of this lamp was mounted on an ornate column with excellent results both by day and night. A most important development in flaming arc lamps was the introduction of the long-burning impregnated-carbon electrode. This feature alone has made the lamp much more serviceable for all high-power illumination and particularly for the lighting of important streets, in which it is now bound to be used as extensively as in Europe. Together with the long-burning electrodes have come a much more compact design of the lamp and better light distribution, all these aiding materially in extending the use of this powerful and efficient illuminant.

THE ELECTRICAL ENGINEERS' BALL.—This annual function, which is to take place at the Hotel Cecil on Friday, the 16th inst., promises to be a great success. All those who have not as yet secured tickets and made arrangements for attending should do so promptly, through some member of the Committee, or the Hon. Secretaries, Messrs. A. M. Sillar and H. Alabaster.

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Electrical Contractors' Section.

Contracts Open and Accepted, and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

CORPORATION OF BRISTOL.

ELECTRICITY DEPARTMENT.

The Electrical Committee will be glad to receive Tenders for a twelvemonth's supply of the following :—

(a) Arc lamp Carbons.
(b) Joint and Fuse Boxes.
(c) A.C. Meters.
(d) D.C. Mercury Type Ampere-hour Meters.

Copies of the Specification may be obtained of the undersigned on payment of a deposit of *Two Guineas for each section*, which will be returned on receipt of a bona-fide tender.

Sealed Tenders, addressed to the undersigned, to be delivered by 10 a.m. on Tuesday, February 20, 1912.

The lowest or any Tender will not necessarily be accepted.

H. FARADAY PROCTOR,
M.Inst.C.E., M.Inst.E.E.
Engineer and General Manager.

Electricity Department,
Exchange, Corn-street,
Bristol.

TO MANUFACTURERS ONLY

The Commissioners of H.M. Works and Public Buildings are prepared to receive Tenders for the supply of FUSE AND SWITCH BOARDS during a period of one year from April 1, 1912.

Forms of tender, conditions of contract, and all particulars may be obtained on application to the Storekeeper, H.M. Office of Works' Stores, 12, Lambeth Palace-road, London, S.E.

Samples of the Boards for which it is proposed to tender should be delivered at once to the Storekeeper, H.M. Office of Works' Engineering Stores, 20, Newington Butts, London, S.E.

The Commissioners do not bind themselves to accept the lowest or any Tender.

Tenders must be delivered before 11 o'clock a.m., on Wednesday, February 21, 1912, addressed to The Secretary, H.M. Office of Works, etc., Storey's Gate, London, S.W., and endorsed "Tender for Fuse and Switch Boards."

H.M. Office of Works, etc.
February 5, 1912.

ST. PANCRAS BOROUGH COUNCIL.

The St. Pancras Borough Council invite Tenders for the supply of ARC LAMP CARBONS. Delivery to be made as required.

Copies of the Specification, Conditions of Contract, and Form of Tender can be obtained upon application at the Electricity Department Offices, No. 57, Pratt-street, Camden Town, N.W., on payment of a deposit of £2, which will be refunded only on the Specification being returned accompanied by a bona fide Tender.

Tenders to be sent to the undersigned, endorsed "Tender for Arc Lamp Carbons," by 12 o'clock noon, on Thursday, March 7, 1912.

The Council do not bind themselves to accept the lowest or any tender.

C. H. F. BARRETT,
Town Clerk.

Town Hall, Pancras-road,
London, N.W.

CITY OF LEEDS.

ELECTRIC LIGHTING DEPARTMENT.

TURBO-ALTERNATOR, CONDENSER, PIPES, ETC.

The Leeds City Council are prepared to receive Tenders for a Steam Turbine, Two-phase Alternator and Exciter, of 6,000 kw. capacity, running at a speed of 1,000 r.p.m.; Electrically-driven Surface Condensing Plant and the necessary Steam, Exhaust, and Water Pipes, etc.

Tenders must include the whole of the work specified, as offers of separate sections will not be considered. Copies of the general conditions, specification, and form of tender, may be obtained from Mr. Harold Dickinson, Manager of the Department, 1, Whitehall-road, Leeds, on payment of a deposit of two guineas, which will be refunded on receipt of a bona fide Tender.

Tenders must be in the form attached to the Specification, and must be delivered to me at the Town Hall, Leeds, not later than 10 o'clock in the forenoon, on Saturday, the 9th day of March, 1912, in sealed envelopes, endorsed "Electric Lighting—Tender for Generating Plant."

The Corporation do not bind themselves to accept the lowest or any of the Tenders sent in.

ROBERT E. FOX,
Town Clerk.

Leeds, February 8, 1912.

BATTERSEA BOROUGH COUNCIL.

The Council invite Tenders for the supply of the undermentioned materials for the Electricity Department for one year from April 1 next :—

1. Oils.
2. Engine room stores.
3. Electricity meters.
4. Service joint boxes.
5. Carbon filament lamps.
6. Metallic filament lamps.
7. Ironmongery, tools, etc.

Forms of Tender may be obtained of the Electrical Engineer, Electricity Works, Lombard-road, Battersea, and no Tender will be considered unless made on such form.

Persons tendering must pay the Trade Union rate of wages in *all* departments.

Additional copies of forms of tender may be obtained upon payment of 2s. 6d. each.

Tenders sealed and endorsed "Tender for ," must be delivered to me at the Town Hall, Battersea, by 12 noon, February 20.

W. MARCUS WILKINS,
Town Clerk.

February 6, 1912.

PONTYPRIDD URBAN DISTRICT COUNCIL.

ELECTRIC LIGHT AND TRAMWAYS DEPARTMENT.

The above Council invite Tenders for the supply of the following Stores and Materials for the year ending March 31, 1913 :—

1. Installation Stores and Sundries.
2. Cables and Wires.
3. Tramcar and Tramway Equipment.
4. Glass and Globes.
5. Insulating Material.
6. Meters.
7. Timber.

OSRAM-LAMPS

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CONTRACTS—*continued.*

Particulars and forms of tender may be obtained on application to the Electrical Engineer, Generating Station, Treforest, Pontypridd.

Tenders on the prescribed forms, sealed and endorsed "Tender for " (as the case may be) must be received by the undersigned on or before Wednesday, February 21, 1912.

The Council do not bind themselves to accept the lowest or any Tender.

J. COLENSO JONES,
Clerk to the Council.

Municipal-buildings, Pontypridd,
February 6, 1912.

BOROUGH OF HAMMERSMITH.

GENERAL ELECTRICITY STORES.

The Borough Council invites Tenders for the supply of the following stores for the year ending March 31, 1913 :—

a. Arc Lamp Globes, etc.
b. Incandescent Electric Lamps.
c. Brooms and Brushes, etc.
d. Carbons.
e. Electric Light Sundries.
f. Fire Bricks, Clay & Lime.
g. Files.
h. Insulated Wires.
i. Metals, Steam Tubes, Screws, etc.
j. Meters.
k. Oilman's Goods and Steam Packing, etc.
l. Tools.
m. Cable Joint Boxes, Fuse Boxes and Connections.
n. Oils.
o. Steam Valves and Cocks.

Forms of Tender and further particulars can be obtained on application to Mr. G. G. Bell, Borough Electrical Engineer, 85, Fulham Palace-road, W., upon receipt of a stamped addressed envelope.

Sealed Tenders, properly endorsed, must be delivered to me at the Town Hall, Hammersmith, not later than 4 p.m., on Wednesday, February 21, 1912.

The Council does not bind itself to accept the lowest or any Tender.

H. THOMPSON,
Town Clerk.

Town Hall, Hammersmith, W.,
February 6, 1912.

COUNTY BOROUGH OF BOURNEMOUTH.

EDUCATION COMMITTEE.

The Bournemouth Education Committee invite tenders for the

WIRING OF THE NEW SCIENCE, ART AND TECHNICAL SCHOOLS AND PUBLIC LIBRARY, LANSDOWNE, FOR ELECTRIC LIGHT.

Full particulars and form of Tender can be obtained, and plans may be seen, on and after Monday, February 12, at the office of the Borough Engineer, provided that the sum of £2 2s. has been previously deposited with him in respect of such tender, which deposit shall become forfeited unless a tender complying with the conditions is sent in, and unless the form of Tender, Specification and Conditions and other particulars are returned intact.

Tenders to be sent in, in envelopes provided for the purpose, to the Secretary to the Education Committee (F. W. Ibbett, Esq.), Municipal Buildings, Bournemouth, not later than noon of Monday, February 26, 1912.

The Education Committee do not bind themselves to accept the lowest or any Tender.

F. W. LACEY, F.R.I.B.A., M.I.E.E.,
Architect to Education Committee.

Municipal Buildings, Bournemouth,
February 6, 1912.

Contracts Open.

HOME.

BATTERSEA.—The Borough Council invite tenders for the following materials for the Electricity Department :—(1) oils ; (2) engine room stores ; (3) electricity meters ; (4) service joint boxes ; (5) carbon filament lamps ; (6) metallic filament lamps ; (7) ironmongery, tools, etc. Particulars from the Electrical Engineer, Lombard-road. February 20. See Official Notice.

BIRKENHEAD.—The Corporation invite tenders for the supply of continuous current electricity meters (ordinary and prepayment types), house-service fuse-boxes, low tension main cable, I.R. lead-covered and armoured service cable. Particulars (£1 1s., returnable) from Mr. William Wyld, Corporation Electricity Works, Craven-street. February 13.

BOURNEMOUTH.—The Corporation of the County Borough (Education Committee) invite tenders for the wiring of the new Science, Art and Technical Schools, and Public Library, Lansdowne, for electric light. Particulars (£2 2s., returnable) from the Borough Engineer. February 26. See Official Notice.

BRISTOL.—The Electricity Department of the Corporation invite tenders for a twelvemonth's supply of (a) arc lamps, (b) joint and fuse boxes, (c) A.C. meters, (d) D.C. mercury type ampere hour. Particulars (£2 2s. each section, returnable) from Mr. H. Faraday Proctor, M.Inst.C.E., M.I.E.E. February 20. See Official Notice.

BRISTOL.—The Docks Committee of the City Council invite tenders for the supply and delivery, testing and maintenance for 12 months after they shall have been taken into public use, of Cables, Switchboards and Electric Arc and Incandescent Lighting at the Avonmouth Docks. Particulars (£5, returnable) from the Secretary of the Docks Committee, 19, Queen-square. February 19.

LEEDS.—The City Council invite tenders for the supply of a steam turbine, two-phase alternator and exciter, of 6,000 kw. capacity, running at a speed of 1,000 r.p.m. ; electrically-driven surface condensing plant, and the necessary steam, exhaust and water pipes, etc. Particulars (£2 2s., returnable) from Mr. Harold Dickinson, Manager of the Department, 1, Whitehall-road. March 9. See Official Notice.

LEEDS.—The Corporation invite tenders for the supply of 1,000 alternating current watt meters, to be delivered as required on or before June 30, 1913. Particulars from Mr. H. Dickenson, Manager, Electric Lighting Department, 1, Whitehall-road. February 14.

MANCHESTER.—The Tramways Committee of the City Corporation invite tenders for the supply of tramcar-type ampere-hour meters. Particulars from Mr. J. M. McElroy, General Manager, 55, Piccadilly. February 20.

MANCHESTER.—The Corporation invite tenders for the supply and erection of (1) high pressure steam and feed pipes and supports connected to two marine type boilers ; (2) work required in connection with the installation of a battery of 16 patent sand filter units in roof tanks. Particulars (£1 1s. each, returnable) from Mr. F. E. Hughes, Secretary, Electricity Department, Town Hall. February 14.

PONTYPRIDD.—The Urban District Council (Electric Light and Tramways Department) invite tenders for the supply of (1) installation stores and sundries ; (2) cables and wires ; (3) tramcar and tramway equipment ; (4) glass and globes ; (5) insulating material ; (6) meters ; (7) timber. Particulars from the Electrical Engineer, Generating Station, Treforest. February 21. See Official Notice.

POPLAR.—The Borough Council invite tenders for extensions to the existing e.h.t. and d.c. switchboards at the Electricity Works, Glaucus-street, Bromley-by-Bow, and the sub-stations in Millwall. Particulars (5s.) from Mr. J. Horace Bowden, Borough Electrical Engineer and Manager, Glaucus-street. February 14.

WALTHAMSTOW.—The Urban District Council invite tenders for the following stores :—Electricity Department : (1) Cables ; (2) jointing materials ; (3) electrical fittings and accessories ; (4) arc lamp carbons ; (5) electricity meters ; (6) ironmongery and tools ; (7) lamps ; (8) engine room stores ; (9) lubricating oils and grease. Tramways Department : (10) castings ; (11) car accessories, including steel tyres ; (12) paints, varnishes and brushes. Particulars from Mr. G. R. Spurr, Electrical and Tramways Engineer, Electricity Works, Priory-avenue. February 23.

BLAKE & INSULATING STAPLES
Write for Samples and Prices.
MOSSES & MITCHELL,
Chiswell Works, 122-124, GOLDEN LANE, E.C.

VULCANITE
TURNED & MOULDED GOODS TO PATTERN.
RODS, SHEETS, AND TUBES.
F. CARSON & EVANS.
34 Fenchurch Buildings
LONDON, E.C.
EBONITE

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THE Great Central Railway IS **The Line for Winter Travel.**

Express Restaurant Car Trains LONDON (MARYLEBONE)

AND

RUGBY, LEICESTER, NOTTINGHAM, SHEFFIELD, YORK, LEEDS, HALIFAX, BRADFORD, HUDDERSFIELD, MANCHESTER, &c.

☛ **CROSS COUNTRY EXPRESSES ARE A DISTINCT FEATURE OF THE GREAT CENTRAL SERVICE.**

NEWCASTLE, SUNDERLAND, DURHAM, YORK, MANCHESTER, BRADFORD, HUDDERSFIELD, ROTHERHAM and SHEFFIELD are provided with through Luncheon Car trains Via NOTTINGHAM, LEICESTER and BANBURY, to and from OXFORD, SOUTHAMPTON, BOURNEMOUTH, and the SOUTH WESTERN LINE, also to and from GLOUCESTER, CHELTENHAM, NEWPORT, CARDIFF, BARRY and SOUTH WALES.

BATH and BRISTOL (with direct connections for the West of England) are reached by through Breakfast and Luncheon Car Trains from LEEDS, WAKEFIELD, HALIFAX, HUDDERSFIELD, SHEFFIELD, NOTTINGHAM and LEICESTER.

Via MARYLEBONE is LONDON'S POPULAR ROUTE for STRATFORD-ON-AVON.

THE CONTINENT is reached by Express Boat Trains to GRIMSBY and regular sailings to HAMBURG, ROTTERDAM and ANTWERP.

EXPRESS TRAINS are VESTIBULED, and include BREAKFAST, LUNCHEON or DINING CARS.

For particulars of Train Service, Special Travel facilities and other information apply at any Great Central Station or Agency, Dean and Dawson's Offices, or send postcard to Publicity Dept., 216, Marylebone Road, London, N.W.

SAM FAY, General Manager.

That Worried Look

is caused by the Printing account he is inspecting, and the fact that despite its size he has had no benefit from it. Frankly, he could not look otherwise, because he has not had his work done by us. Our customers pay their bills cheerfully, for they get satisfactory results and increased trade from the use of our work. Remember—"Smiths' Printing Produces Purchasers," so don't wear a worried look, try us as a cure.

PRINTERS OF THE ELECTRICAL ENGINEER.

SMITHS' PRINTING CO. (LONDON & ST. ALBANS), LTD.,

Head Office and Works:
28-32, HUTTON STREET, WHITEFRIARS, E.C.

Telephones: 1030 Holborn. 13055 Central.
Telegrams: "Printable, London."

Country:
FLEET WORKS, ST. ALBANS.

Telephone: 31 St. Albans.
Telegrams: "Printable, StAlbans."

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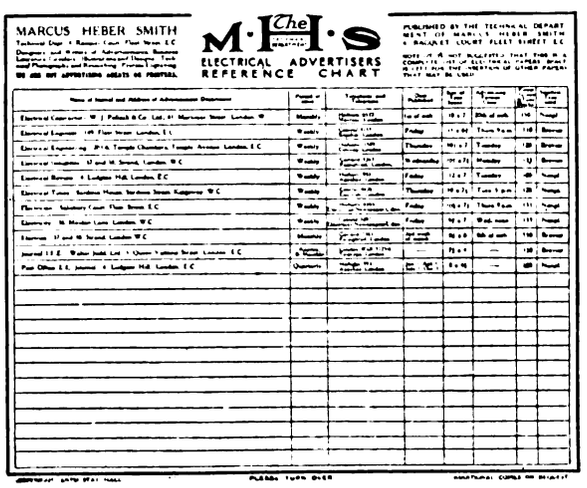
PUBLICITY SECTION.

Notes on Novelties, Trade Specialities, New Catalogues and Lists, &c.

Advertisers' Reference Chart.

We give herewith a reproduction of the Electrical Advertisers' Reference Chart, which has been devised by Mr. Marcus Heber Smith, of 4, Racquet-court, Fleet-street. It is pointed out that the advertising of machinery and plant is a matter beset with many difficulties. Sensational or unusual methods are not in harmony with the product advertised or the nature of the business. Mr. Marcus Heber Smith makes a speciality of this difficult class of advertising


MARCUS HEBER SMITH

M·H·S

ELECTRICAL ADVERTISERS REFERENCE CHART

in the shape of designs for advertisements, booklets, personal letters, and circulars, technical photography, process engravings, etc. For a good many years Mr. Heber Smith's firm has been in constant association with the keenest and most successful men in the engineering industry on the subject of technical advertising, and have amassed information which should be of great value in elucidating the problem of successful and effective announcements. They are, however, neither printers nor advertising agents.

Electric Radiators.

We have received from Messrs. Siemens Brothers Dynamo Works, Ltd., their latest list, No. 3D, dealing with their newest types of electric radiators, which should be in the hands of all contractors dealing in electrical supplies of this kind. Copies will be sent on application to the Tyssen-street Works at Dalston.

Osram Lamps for the Post Office.

The General Electric Company, Ltd., re-secured the Post Office contract for the supply of metal filament lamps for the forthcoming six months, all lamps to be English made. This contract has been secured after the Post Office authorities had carried out exhaustive tests on both English and foreign lamps, and it includes every type for which the company has tendered from 25 volt to 5 c.p.

The Thomas Transmission.

The Thomas Transmission, Ltd., have received notification from the Royal Automobile Club to the effect that the R.A.C. Committee has awarded them the Dewar Trophy for the most meritorious performance in connection with the certified trials held under the regulations and observation of the Club during 1911. The award is made upon the results obtained in trials carried out last year with a lorry and a touring car, each fitted with the Thomas Transmission. The award opens up the possibility of very extensive developments in electrical traction of all kinds by road and rail.

GREAT CENTRAL EXCURSION.

The Great Central Company's programme of excursion facilities from London (Marylebone) contains in concise form a vast amount of useful information for those who wish to take advantage of the cheap travel facilities to the Midlands, Yorkshire, Lancashire, and North of England during the months of January, February and March. On alternative Saturdays tickets at low fares are issued to numerous stations, available in many cases by express trains, the compartments of which are well lighted, and maintained at a genial temperature. Those who wish to spend a day or half day in the country will find low fares are charged several days a week to the Chiltern Hills and Vale of Aylesbury. Week-end and Tourist Tickets can also be obtained to a large number of places. In each case the train times for both the outward and homeward journeys are given, with the fares, and the periods for which they are available opposite each particular station, thus enabling the traveller to obtain the desired information at a glance. Copies of this excellent programme can be had free at Marylebone Station, G.C.R. Town Offices, or post free from Publicity Office, 216, Marylebone-road, N.W.

THE SOCIETY OF ENGINEERS.

The first Ordinary Meeting of the present Session was held on Monday at the Institution of Electrical Engineers, Victoria-embankment, W.C. The chair was first occupied by the retiring president, Mr. F. G. Bloyd, who presented the following premiums awarded for papers published in the Journal during 1911:—The President's Gold Medal to Mr. W. R. Baldwin-Wiseman for his paper on "The Administrative Aspect of Water Conservancy"; the Clarke Premium to Mr. T. J. Gueritte for his paper on "The Mechanical Installation and Upkeep of Permanent Way on Railways"; the Bessemer Premium to Mr. R. W. A. Brewer for his paper on "Two-Stroke Cycle Engines"; a Society's Premium to Mr. E. Kilburn Scott for his paper on "Nitrogen Products made with the aid of Electric Power"; a Society's Premium to Mr. F. G. Woollard for his paper entitled "Some Notes on Drawing Office Organization." Mr. Bloyd then vacated the chair in favour of Mr. John Kennedy, the President for 1912, who was received with acclamation. A vote of thanks to the retiring President was proposed and heartily accorded.

LONDON ELECTRICAL ENGINEERS.—Officer commanding, Lieut.-Colonel H. M. Leaf. The following orders have been issued for the current week:—Monday, February 12—"A" Company: Technical Work, 7 to 8 p.m.; Lecture on Military Telephones, 8 to 9 p.m.; Technical Work, 9 to 10 p.m.; Tuesday, February 13—"B" Company: Technical Work, 7 to 8 p.m.; Lecture on Military Telephones, 8 to 9 p.m.; Technical Work, 9 to 10 p.m. Thursday, February 15—"C" Company: Technical Work, 7 to 8 p.m.; Lecture on Military Telephones, 8 to 9 p.m.; Technical Work, 9 to 10 p.m. Friday, February 16—"D" Company: Technical Work, 7 to 8 p.m.; Lecture on Military Telephones, 8 to 9 p.m.; Technical Work, 9 to 10 p.m. Saturday, February 17:—Mobilisation week-end run at Dover. The party for this run will parade at Charing Cross Station, L.C. and S.E. Railway, at 2.10 p.m. for the 2.22 p.m. train sharp. Dress: Service Dress, Putties, Great-Coats, Belts and Haversacks. No arms will be taken. (Signed) J. H. S. Phillips, Major, for O.C. London Electrical Engineers.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns per week.			Increase or decrease.		Miles of track open		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1911-12	1910-11	Week.	Current year	1911	1910.	Ending	Total receipts.	Passengers carried.	Car miles run.	Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Jan. 24	1,411	1,188	+ 223	+ 3,114	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5· 3
Ayr Corporation	Aug 12	550	572	— 22	—	8	8	—	—	—	—	—	—	—	—
Birkenhead Corporation	Feb. 4	1,121	1,064	+ 57	+ 1,886	24·089	24·089	Mar 31	56,713	12,544 501	1,207,761	1·089	11·13	2,315	6·74
Birmingham Corporation	Jan. 27	10,128	6,923	+ 3,205	+ 81,778	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Aug. 23	1,304	1,002	+ 302	+ 2,392	14·62	—	Mar. 25	58,367	10,310,965	1,041,021	1·27	12·60	3,915	36
Blackpool Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Feb. 3	271	284	— 13	+ 39	—	—	Dec. 31	35,210	2,939,144	592,312	—	—	—	—
Bolton Corporation	Jan. 28	2,289	2,261	+ 28	+ 6 286	46	42	Mar. 31	121,707	27,018,149	2,641,292	1·08	11·05	2,897	6·58
Bournemouth Corporation	Jan 31	1,326	1,280	+ 46	+ 595	30	21·95	,, 31	89,695	14,686,368	1,782,706	1·46	12·07	3,064	7·76
Bradford Corporation	Aug. 5	5 573	5,706	— 133	+ 8,201	100	54·81	—	—	—	—	—	—	—	—
Brighton Corporation	Feb. 4	617	676	— 29	+ 2,501	9·5	—	,, 31	49,124	10,708,184	1,126,676	1·101	10·464	2,857	—
Bristol Tramway Company	Feb. 2	5.558	5,316	+ 242	+ 2,508	57	57	Dec. 31	308,615	47,454,560	5,914,713	-	—	—	—
Burnley Corporation	Feb. 3	1.192	1,273	+ 89	—	22	22	Mar. 31	65,295	12,911,113	1,263,118	1·21	12·41	6,067	7·89
Burton Corporation	Feb 4	234	225	+ 9	+ 671	10	6⅛	,, 31	15,368	3,131,172	432,911	1·07	7·75	1,416	6·41
Cardiff Corporation	Jan. 27	2,194	2,131	— 62	+ 7,806	17·35	17·35	,, 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Central London Railway	Feb. 3	5,126	5,438	— 312	— 1,747	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,780	2·01	5·769	55,404	30·27a
City and South London Railway	Feb. 4	3,448	3,501	— 53	— 561	7·26	7·26	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	Feb. 1	378	397	— 19	+ 66	9·89	9 89	Dec 31	25,497	5,704,071	899,173	1.07	6·80	2,578	—
Croydon Corporation	Jan. 19	1,580	1,476	+ 104	+ 5,280	11⅝	—	Mar. 31	85,806	19,476,576	2,269,500	1·057	9·07	4,428	—
Darwen Corporation	Dec. 29	—	—	—	—	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Jan. 20	188	161	+ 27	+ 1,465	7	7	,, 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Feb. 2	111	106	+ 5	+ 15	7	7	Dec 31	7,472	449,677	146.081	4·0	12·27	1,067	8·38
Dublin U.T.	Feb. 2	4,884	4,858	+ 26	— 1,366	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	July 19	1,238	1.210	+ 28	— 83	28	—	May 15	62,328	16,843,909	1,322,894	·87	11·30	—	7·28
East Ham Corporation	Feb. 3	986	914	+ 72	+ 2,885	15	14	Mar. 31	53,287	16,059,912	1,303,753	·78	9·81	3,750	7·57
Glasgow Corporation	Feb. 3	16,623	16,233	— 390	+ 37,641	196	195½	May 31	893,591	222,730,571	20,974,016	·96	10·22	4,706	5·75
Gloucester Corporation	—	—	—	—	—	15	—	—	—	—	—	—	—	—	—
Halifax Corporation	Sept. 5	2,186	1,954	+ 232	+ 5,375	37·171	37	Mar. 31	92,609	17,067,856	1,909, 97	1·30	11·64	2,456	—
Huddersfield Corporation	A g. 19	2.298	1,965	+ 300	+ 4,324	29	28½	,, 31	96,185	19,001,660	2,058,663	1·22	11·21	3,375	6·31
Hull Corporation	Feb. 3	2,848	2,706	+ 141	+ 7,230	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Sept. 2	545	526	+ 19	+ 5	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Jan. 24	119	110	+ 9	+ 133	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Jan. 24	1,134	1,162	— 28	+ 4	39	39	Dec. 31	68,689	13,755,329	2,272,765	—	—	—	—
Leeds Corporation	S pt 9	7,689	7.174	+ 51	+ 12,730	108	108	Mar. 31	357,610	78,385,015	8,152,990	1·08	10·41	3,311	5·42
Leicester Corporation	Feb. 5	2 303	2,129	+ 173	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Jan. 20	11,103	10,470	+ 633	+ 2,674	116	109	Dec. 31	582,276	125,507,283	12,235,408	1·106	11·42	5,020	7·955
Liverpool Overhead Railway	Feb. 4	1,480	1,303	+ 177	+ 548	6·65	2·40	June 30	79,004	11,171,515	1,166,386	—	—	—	—
London County Council	Jan. 24	42,005	39,890	+ 2,115	+ 96,398	13⅜	133½	Mar. 31	1,891,035	418,317,377	39,545,512	1·06	11·48	—	6·42
London Electric Railway	July —	60.847	58,978	+ 1,208	—	21·25	21·25	—	—	—	—	—	—	—	—
Lowestoft Corporation	Feb. 4	143	121	— 22	+ 24	3½	—	Sept. 30	10,896	2,377,316	329,958	1·07	7·9	2,179	6·82
Maidstone Corporation	Mar. 6	157	100	+ 7	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Feb. 3	14,557	14,607	— 50	+ 36,123	183	183	Mar. 1	810,094	165,800,077	17,367,200	1·16	11·19	4,667	7·17
Metropolitan District Railway	Feb. 3	12,538	11,859	+ 679	+ 3,348	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Feb. 4	16,846	16,726	+ 120	+ 866	24½	24½	Dec. 31	718,089	102,849,458	—	1·48	—	—	—
Nelson Corporation	Feb. 3	132	129	+ 3	+ 1 570	2⅞	2⅞	Mar 31	7,576	2,118,878	203,708	—	8·93	—	—
Newcastle-on-Tyne Corporation	Jan 27	4,080	3,878	+ 202	+ 14,456	60¼	59½	,, 31	206,130	45,335,207	4,437,639	1·09	11·15	3,421	—
Newport (Mon.) Corporation	Dec 30	726	787	— 61	+ 944	14½	14½	,, 31	35,146	8,452,562	895,238	·99	9·42	2,425	—
Oldham Corporation	Aug. 13	2,137	1,886	+ 227	+ 2,543	36⅜	35	,, 25	97,842	19,125,202	1,893,777	1·15	12·399	2,653	8·817
Portsmouth Corporation	April 29	1,788	1,783	+ 5	— 1,240	15½	28½	Mar. 31	102,978	23,053,717	2,291,767	1·10	10·15	—	—
Reading Corporation	April 27	570	556	+ 13	+ 171	13½	13½	,, 31	32,506	7,834,575	909,439	·96	8·28	4,183	4·98
Rochdale Corporation	Sept. 9	1,539	1,296	+ 243	+ 4,823	27	20·93	,, 31	63,000	11,360,871	1,402,532	1·31	10·774	—	—
Rotherham Corporation	Aug. 31	655	645	+ 10	+ 1,412	12	9·39	,, 31	33,313	6,960,178	722,393	—	11·06	—	—
Salford Corporation	Sept. 4	4,872	4,907	— 37	+ 6,056	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	April 23	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Feb 3	6,131	5,929	+ 202	+ 18,521	40	40	Mar. 25	316,739	84,500,331	7,618,383	·900	9·978	4,144	—
Southampton Corporation	Aug 16	1,471	1,281	+ 190	+ 3,372	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 2	980	1,253	— 273	+ 1,489	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Aug. 6	1,594	1,553	+ 41	+ 3,128	20	20	,, 31	58,889	14,561,672	1,451,906	·97	9·73	2,944	—
Swindon Corporation	Nov. 8	155	138	+ 17	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	—	—	—	—	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey Corporation	Feb. 3	891	82:	+ 67	+ 6,279	12·68	12·45	Mar. 31	49,835	9,990,653	1,059,629	1·19	11·28	3,971	—
Warrington Corporation	Dec. 28	498	465	+ 33	+ 476	9⅜	9·656	,, 31	20,169	5,266,980	435,774	·915	10·939	2,064	6·281
West Ham Corporation	Mar 23	2,445	2,250	+ 195	—	27·8	27·8	Mar 31	127,066	36,846,649	2,907,805	·801	10·21	4,518	7·22
Wolverhampton Corporation	Jan. 24	759	838	— 79	—	25	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6.509

Train Miles. A Half-years' figures

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CLASSIFIED DIRECTORY.

MANUFACTURERS AND MERCHANTS.

Accumulators.
Essex Accumulator Co., Leytonstone, London, N.E.
Hart Accumulator Co., Marshgate-lane, Stratford.
Johnson & Phillips, Old Charlton, Kent.

Accumulator Acid Manufacturers.
Spencer, Chapman & Messel, 36, Mark-lane, London, E.C.

Acid Proof Paints.
Griffiths Bros., Mack's-road, Bermondsey, S.E.

Ammeters and Voltmeters.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Arc Lamp Hoists.
London Electric Firm, George-st., Croydon.

Auto-Transformers.
British Westinghouse Electrical and Mfg. Co., Manchester.
Johnson & Phillips, Old Charlton, Kent.

Batteries (Primary) and Accessories.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W.

Belting.
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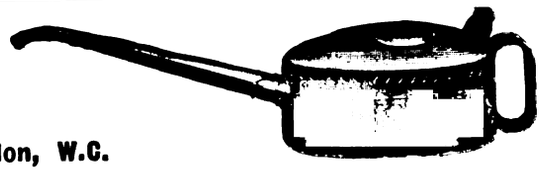

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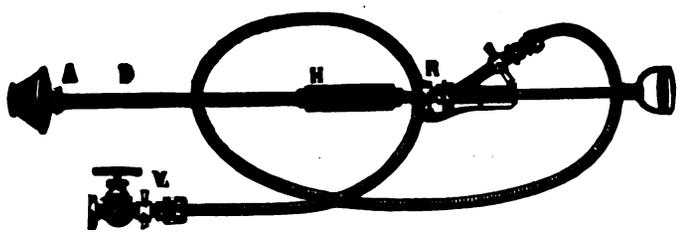

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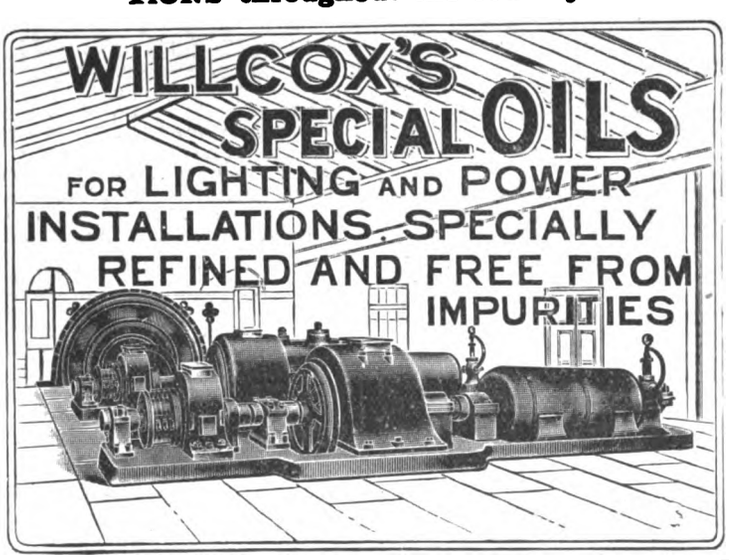

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